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ABSTRACTS 1–711

VOLUME 55 **JANUARY 1952** NUMBER 649

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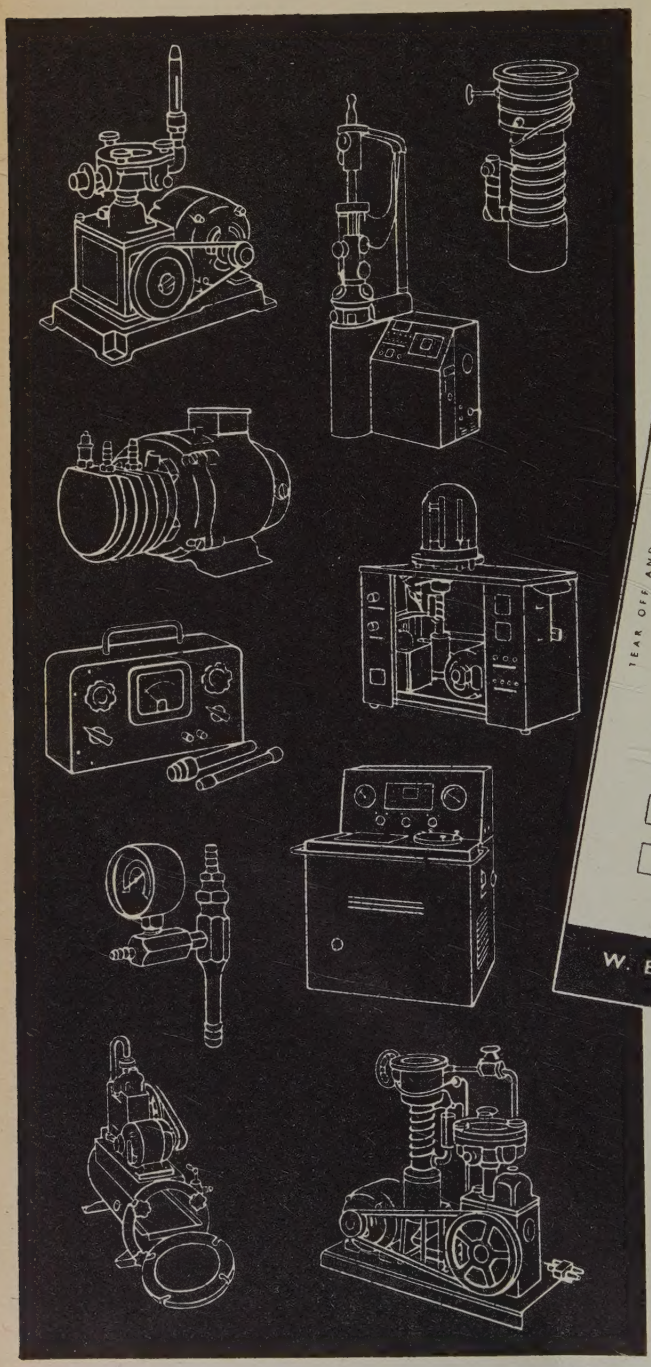

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Electronic relays and counters
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Applied electrochemistry
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Thermionic tubes
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X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplements published with the Indexes to Volume 53 (1950) and Volume 54 (1951). Reprints of the List of Journals (1950) and the Supplements (1950, 1951) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Aero. Res. Coun. Curr. Pap.*	*Aeronautical Research Council (Ministry of Supply) Current Papers.* H.M. Stationery Office, Kingsway, London, W.C.2.
**Alluminio*	*Alluminio.* Organo dell' Istituto Sperimentale dei Metalli Leggeri. Via della Posta 8–10, Milan.
Electricien	*L'Electricien.* 92 Rue Bonaparte, Paris, VI^e^.
**Marconi*	*Marconi.* Via Hermada 2, Genova-Sestri.
**Mem. 52 Riun. A.E.I. (Florence, Sept., 1951)*	*Memorie della 52 Riunione dell' Associazione Elettrotecnica Italiana.* Via S. Paolo 10, Milan.
**Publ. Nat. Res. Coun. Nat. Acad. Sci.* [*Wash.*]	*Publications of the National Research Council of the National Academy of Sciences.* 2101 Constitution Avenue, Washington 25, D.C.
Safety Min. Res. Establ. Res. Rep.	*Safety in Mines Research Establishment Research Report.* Ministry of Fuel and Power, Safety in Mines Research Establishment, Portobello Street, Sheffield 1.
Tech. Rep. Engng Res. Inst. Kyoto Univ.	*Technical Reports of the Engineering Research Institute of Kyoto University.* Kyoto.
Adv. Phys.	*Advances in Physics.* Quarterly Supplement of the Philosophical Magazine. Taylor and Francis, Red Lion Court, Fleet Street, London, E.C.4. Vol. 1, No. 1 dated January, 1952. Price per part 15s. 0d. Price per annum £2 15s. 0d.

Notes

Analytical Chemistry *Industrial and Engineering Chemistry*	Alteration to address: American Chemical Society, 1155 16th Street N.W., Washington 6, D.C.
Journal of Physical and Colloid Chemistry	Change of title as from January, 1952, to *Journal of Physical Chemistry* [*J. Phys. Chem.*]. Address changed to American Chemical Society 1155 16th Street N.W., Washington 6, D.C.
Zh. Eksper. Teor. Fiz.	*Zhurnal Eksperimentalnoĭ i Teoreticheskoĭ Fiziki*: Formerly listed as *J. Exp. Theor. Phys., USSR.* [*Journal of Experimental and Theoretical Physics.*]
Zh. Tekh. Fiz.	*Zhurnal Tekhnicheskoĭ Fiziki*: Formerly listed as *J. Tech. Phys., USSR.* [*Journal of Technical Physics.*]

Erratum

Abstr. 9804 (1951), line 5: *for* (Oct., 1950) *read* (Oct., 1951)

MATHEMATICS 51

51

1. An introduction to applied mathematics. J. C. JAEGER. *Oxford: Clarendon Press* (1951) 445 *pp.*

511.1

2. Binary numeration before Leibniz. J. W. SHIRLEY. *Amer. J. Phys.*, **19**, 452–4 (*Nov.*, 1951).

512.9 : 621.396.611.21

3. The practical execution of the transformation of tensors of the third and fourth degrees. R. BECHMANN. *Arch. elekt. Übertragung*, **5**, 360–2 (*Aug.*, 1951) *In German.*

517.152.2 : 621.3.018.42

4. A series expansion of the Fourier integral. W. A. WHITCRAFT, JR. *Proc. Inst. Radio Engrs*, **39**, 1087–9 (*Sept.*, 1951).

Evaluation of the Fourier integral by parts leads to two different series representations of a time function in the frequency domain. These series involve powers of the frequency variable and either derivatives or integrals of the function, evaluated at the upper time limit only. The method has been used successfully in studies of bandwidth requirements for pulsed transmissions. It is necessary that the function treated be analytic between the time limits imposed. The convenience of the formulation then follows from choosing the time limits symmetrically. A.

517.93

5. Determination of the constants of integration in the solution of a high-order differential equation. O. M. BOGATYREV. *Elektrichestvo, No.* 8, 74–81 (*Aug.*, 1951) *In Russian.*

The two methods given are valuable for simplifying the calculation of transient processes in complex electric systems. The first method is based on the operator representation of the differential equation of the required function with subsequent use of Heaviside's expansion formula, while the second method leads to a direct computation of the constants of integration by formulae derived from a systematic successive reduction and solution of a system of algebraic equations. B. F. KRAUS

518.3 : 519.2

6. An alignment chart for Monte Carlo solution of the transport problem. B. I. SPINRAD, G. H. GOERTZEL AND W. S. SNYDER. *Nat. Bur. Stand. Appl. Math. Ser., No.* 12, 4–5 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. A nomogram is constructed to simplify the random sampling to be carried out to produce a stochastic system simulating the solution [for $Q(x)$] of integral equations of type

$$Q(x) = f(x) + \lambda \int_a^b K(|x - t|)Q(t)dt.$$ N. L. JOHNSON

518.4

7. The solution of polynomial equations with the aid of the electrolytic tank. L. TASNY-TSCHIASSNY AND A. G. DOE. *Aust. J. Sci. Res. A*, **4**, 231–57 (*Sept.*, 1951).

A practical method is presented of solving polynomial equations with real or complex coefficients with the aid of an electrolytic tank. The roots may be determined with any desired degree of accuracy by means of an iterative procedure. A method of generating the electrode currents, and a method of ascertaining root points with the aid of a rotatable quadruple probe assembly and passive phase shifting and differential networks are described. A mathematical investigation of the accuracy to be expected is made, and tests have been carried out in a tank, verifying the theoretical conclusions. The methods developed are applicable to the computation of the complex values of rational functions, for instance, impedance functions. A.

518.5

8. Precise solutions of linear simultaneous equations using a low cost analog. S. ACKERMAN. *Rev. Sci. Instrum.*, **22**, 746–8 (*Oct.*, 1951).

When solutions of analogue computers are used as tools in conjunction with techniques readily handled by standard desk calculators rather than as direct solutions, any desired accuracy of the final solution can be usually obtained. The emphasis is placed upon obtaining the equivalent of a large scale digital device by combining solutions from analogue computers with techniques readily handled by very small digital devices. A.

518.5 : 621.318.572

9. An electronic digital computor using cold cathode counting tubes for storage. I. R. C. M. BARNES, E. H. COOKE-YARBOROUGH AND D. G. A. THOMAS. *Electronic Engng*, **23**, 286–91 (*Aug.*, 1951).

Designed for work of a repetitive nature which would involve several desk machines, and not for long high-speed calculations. Input is by perforated tape, the output being recorded by perforator or teleprinter (maximum of 8 inputs and 8 outputs). The computor works on a decimal basis, by parallel operation; it has a capacity of 90 8-digit numbers and 20 8-digit stores. No provision is made for reading off tables of functions. Arithmetical operations (addition being the fundamental one, other operations following by standard processes) are each described and transfer and carry circuits explained. Rounding-off after multiplication or division is achieved by the addition of 1 or 0 at random to the 8th figure of product or quotient. A. J. KENNEDY

518.5 : 621.318.572

10. An electronic digital computor using cold cathode counting tubes for storage. II. R. C. M. BARNES, E. H. COOKE-YARBOROUGH AND D. G. A. THOMAS. *Electronic Engng*, **23**, 341–3 (*Sept.*, 1951).

For Pt I, see preceding Abstr. An explanation of the functioning of the translator unit and the sequence control of reading in the current order, setting up the connections, arithmetic and printing out operations. Each switching operation in the sequence is checked before the next commences. The computor is economically suited to similar repetitive calculations on a range of numerical data.

A. J. KENNEDY (R)

518.5 : 621.318.572

11. Nimrod: a small [electronic] automatic computor. R. STUART-WILLIAMS. *Electronic Engng*, **23**, 344–8 (*Sept.*, 1951).

The machine was built for exhibition purposes to display computation principles. The game of Nim (which is described) has been reduced to logical form, numbers being handled in the binary notation. The "and," "or," "not" and "storage" (storing either 0 or 1) elements, are described. One valve type has been used throughout and the whole design directed towards reliability for wide variations in component and valve characteristics. Some examples of logical operations are given. A. J. KENNEDY

518.5 : 621.318.572 : 621.317.727

12. A three dimensional electrical potential analyser. S. C. REDSHAW. *Brit. J. Appl. Phys.*, **2**, 291–5 (*Oct.*, 1951).

Special woven-wire resistance units were assembled in frames with provision for plug and terminal contacts at any point. By analogy such electrical measurements simulate the 3-dimensional form of Laplace's equation and by this method solve the finite difference form of the potential equation. A potentiometer is used to measure potentials within 1 mV with 1 V applied. The analyser has been used to solve several cases of potential flow around aeroplane wings of unconventional shape, but other problems involving the solution of Laplace's equation could also be solved by this apparatus. The theory and some constructional notes are given. E. H. W. BANNER

518.5 : 621.396.615.17 : 621.318.572

13. A digital computer timing unit [for the electronic variable computer (EDVAC)]. R. M. GOODMAN. *Proc. Inst. Radio Engrs*, **39**, 1051–4 (*Sept.*, 1951).

Forty-nine prime pulse sources are required, one of period 1 μsec ("clock pulses") and the 48 others of period 48 μsec ("timing-pulses"), but each displaced in phase by 1 μsec. A system is described, and set out schematically, for the production of such pulses where loads are of low impedance. Variations on the basic system provide a convenient and controlled means of producing a variety of related time-pulses. A. J. KENNEDY (R)

519.283

14. Monte Carlo method. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 42 *pp.* (1951).

The Monte Carlo method may briefly be described as the device of studying an artificial stochastic model of a physical or mathematical process. The novelty lies in the suggestion that where an equation arising in a non-probabilistic context demands a numerical solution not easily obtainable by standard numerical methods, there may exist a stochastic process with distributions or parameters which satisfy the equation, and it may actually be more efficient to construct such a process and compute the statistics than to attempt to use those standard methods. This volume contains some of the papers and discussions from a symposium devoted to the application of the Monte Carlo method in physical problems. For the individual papers see Abstr. 6, 15–21, 88, 380, 567–9 (1952).

519.283

15. Methods of probabilities in chains applied to particle transmission through matter. W. C. DEMARCUS AND L. NELSON. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 9–11 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. Describes the theory of a method of obtaining steady state solutions for a given distribution of sources producing particles inside and upon the surface of a large bulk of matter. The problem reduces to finding the limit, for large k, of A^k, where A is the matrix of probabilities (the same for each particle) of changing from one given state to another at the next collision. N. L. JOHNSON

519.283

16. A Monte Carlo technique for estimating particle attenuation in bulk matter. B. A. SHOOR, L. NELSON, W. DEMARCUS AND R. L. ECHOLS. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 24–6 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. Describes a continuous process, using punched cards, for computing life histories of particles. When one life history is completed the computation of the next begins automatically. N. L. JOHNSON

519.283

17. Estimation of particle transmission by random sampling. H. KAHN AND T. E. HARRIS. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 27–30 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. Three methods of estimating small probabilities (10^{-6} to 10^{-10}) are described. The first, ascribed to J. von Neumann, requires a decision to be made each time a particle moves from one region in phase space to another of greater or lesser "importance." If the particle moves to a region of lesser importance the life history is continued with probability $\frac{1}{2}$, but the result is given double the original weight in those cases which are continued. If the new region is of greater importance, the particle is split into two independent particles, each with one-half the weight of the original. The other two methods are modifications of the first. N. L. JOHNSON

519.283

18. History of Rand's random digits—summary. G. W. BROWN. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 31–2 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952). N. L. JOHNSON

519.283

19. The mid-square method of generating digits. P. C. HAMMER. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 33 (1951).

"Monte Carlo method" symposium [see Abstr. 14 (1952)].

519.283

20. Generation and testing of random digits at the National Bureau of Standards, Los Angeles. G. E. FORSYTHE. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 34–5 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)].

519.283

21. Various techniques used in connection with random digits. J. VON NEUMANN. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 36–8 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. Describes a method of producing random numbers according to an assigned probability law on the Eniac, using random numbers from a rectangular distribution in the interval (0, 1).

N. L. JOHNSON

519.283

22. Problems for the numerical analysis of the future. *Nat. Bur. Stand., Appl. Math. Ser., No.* 15, 21 *pp.* (1951).

Four papers presented at the Symposia on Modern Calculating Machinery and Numerical Methods, Los Angeles, July, 1948. For abstracts, see following.

519.283

23. Some unsolved problems in numerical analysis. D. R. HARTREE. *Nat. Bur. Stand., Appl. Math. Ser., No.* 15, 1–9 (1951).

"Numerical analysis" symposium paper [see Abstr. 22 (1952)]. The following problems are described: Elimination of approximately known roots of polynomial equations; Solution of systems of simultaneous nonlinear algebraic equations; Problems concerning relaxation methods; Characteristic value problems in ordinary differential equations; Motion of a continuous distribution of charge under mutual forces between its parts. The paper concludes with a discussion of the human factor in the use of computing machines. N. L. JOHNSON

519.283

24. Numerical calculations in nonlinear mechanics. S. LEFSCHETZ. *Nat. Bur. Stand., Appl. Math. Ser., No.* 15, 10–12 (1951).

"Numerical analysis" symposium paper [see Abstr. 22 (1952)]. It is suggested that numerical methods can supplement the relatively meagre information obtained by purely mathematical analysis of nonlinear differential equations. Examples from electrical circuit theory are given. N. L. JOHNSON

519.283

25. Linear programing. G. B. DANTZIG. *Nat. Bur. Stand., Appl. Math. Ser., No.* 15, 18–21 (1951).

"Numerical analysis" symposium paper [see Abstr. 22 (1952)]. Many practical problems involving the interaction of large numbers of variables can, effectively, be reduced to the mathematical problem of minimizing a linear function of the variables, subject to a certain number of linear inequalities and/or equalities. An iterative method of solution is described, but this technique, and others which have been devised, usually involve very heavy computation. In large-scale problems, the computations are beyond the scope of modern electronic computers.

N. L. JOHNSON

519.283 : 532.59 : 538.566

26. Wave propagation in hydrodynamics and electrodynamics. B. FRIEDMAN. *Nat. Bur. Stand., Appl. Math. Ser., No.* 15, 13–17 (1951).

"Numerical analysis" symposium paper [see Abstr. 22 (1952)]. The technical difficulties described arise from: "(1) wave propagation in an inhomogeneous medium, (2) existence of complicated boundary conditions, (3) nonlinearity of the appropriate equations, (4) the prescription of boundary conditions on a free boundary and therefore an unknown boundary." It is stated that problems (2) and (3) should be capable of solution with existing calculating machines. N. L. JOHNSON

519.3

27. The canonical formalism in homogeneous form. P. WILKER. *Z. Phys.*, **130**, 245–55 (*No.* 3. 1951) *In German.*

The problem of the motion of a mechanical system is formulated as a parameter problem in the calculus of variations. The canonical equations are written in homogeneous form, using conjugate variables. Canonical transformations are introduced and applied to the Hamilton–Jacobi equation. The case of cyclic variables is discussed. L. S. GODDARD

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.6 : 621.396.822

28. Radio astronomy. J. S. HEY. *Sci. Progr.*, **39**, 427–48 (*July*, 1951).

Describes the principles of radio noise reception and their application to the determination of the temperature of the moon and of the solar atmosphere, and to the investigation of radio stars. Future developments are indicated. 17 refs.

523.165

29. Galactic radiation at 18·3 Mc/s. C. A. SHAIN. *Aust. J. Sci. Res. A*, **4**, 258–67 (*Sept.*, 1951).

Observations are described of radiation over a zone centred on Declination −34°. The results, expressed as equivalent temperatures, are compared with the distribution of intensity at 100 Mc/s. It is found that the temperatures are consistently much higher at 18·3 Mc/s than at 100 Mc/s, but the observed ratio of maximum to minimum at 18·3 Mc/s is less than would have been obtained at 100 Mc/s using an aerial with the same directional diagram. The observations are consistent with the hypothesis that contours of equal equivalent temperature over the sky are of similar shape on the two frequencies. Peaks in the intensity distribution are observed which appear to be due to discrete sources. The observations give information concerning the attenuation of radiation passing through the ionosphere. It is found that *F*-region absorption is higher near the critical frequency than expected, and that *E*-region absorption is lower than expected. It is found that the collision frequency at the height of maximum ionization of the *E*-region is not greater than 10^4 sec^{-1}, and is probably less. For the equipment used, the limit of sensitivity for the reception of radio signals was generally set by galactic noise. A.

523.165

30. An accurate determination of the positions of four radio stars. F. G. SMITH. Letter in *Nature* [*Lond.*] **168,** 555 (*Sept.* 29, 1951).

Measurements on wavelengths of 3·7 m and 1·4 m with two interferometers, using directional aerial systems and parabolic reflectors respectively, are combined to give positions whose accuracy is 1s–3s in R.A., and 0·7′–10′ in Declination. M. W. OVENDEN

523.165

31. A search for long-period variations in the intensity of radio stars. M. RYLE AND B. ELSMORE. Letter in *Nature* [*Lond.*] **168,** 555–6 (*Sept.* 29, 1951).

None of the radio stars observed varies by more than 0·1 magnitude with any period shorter than 1 000 days, on a wavelength of 3·7 m. M. W. OVENDEN

523.6

32. On the origin of comets. V. G. FESENKOV. *Astron. J.* [*USSR*] **28,** 98 (*No.* 2, 1951) *In Russian.* English abstract in *Astron. News Lett.* [*Harvard*] *No.* 57, 10–11 (*Aug.* 10, 1951).

The author considers the formation of comets from a planetary explosion. On the assumption that the fragments were thrown uniformly in all directions with velocities small compared with the orbital velocity of the planet, the numerical distribution of particles with semi-major axis, and the relation between semi-major axis and eccentricity for various values of ejection velocity (v) are derived. The distribution of v is discussed, and a relation $v \propto$ (radius of particle)$^{-\frac{1}{2}}$ considered to be most nearly representative. Observations of the mean motions of minor planets are graphically extrapolated to yield the radius and mass of a minor planet with parabolic velocity. The value of mass, 10^{15} grams, is regarded as close to usual cometary masses. The perturbations by stars upon the orbits of distant comets are discussed, results similar to the more recent work of Oort and van Woerkom being obtained. The physical details involved in the ejection of the cometary fragments are not discussed, but remark is made of the ability of such fragments to retain their original supplies of gas, and augment them from the interstellar medium. M. W. OVENDEN

523.61

33. Origin and development of comets. J. H. OORT. *Observatory,* **71,** 129–44 (*Aug.,* 1951).

A summary of physical observations of comets (including a historical survey) is followed by a discussion of the distribution of semi-major axes of cometary orbits, which leads to the suggestion of a swarm of comets at distances of about 150 000 A.U., stellar perturbations causing occasional approaches to the sun. M. W. OVENDEN

523.75

34. The nature of solar prominences. K. O. KIEPENHEUER. *Publ. Astron. Soc. Pacific,* **63,** 161–7 (*Aug.,* 1951).

A brief discussion of the observational properties of prominences (without distinguishing the different types) and the processes of interaction between prominences and the corona is given. It is suggested that the hydrodynamic experiments of G. I. Taylor [*Proc. Roy. Soc. A,* **100,** 118 (1921)] provide a qualitative analogy to the processes which maintain the sheet-like structure of prominences. M. W. OVENDEN

523.755

35. Ion density in the solar corona. N. A. YAKOVKIN. *Astron. J.* [*USSR*] **28,** 79 (*No.* 2, 1951) *In Russian.*

The final results are presented in a diagram in which the ionic densities are plotted against distance from the edge of the sun. These are compared with similar curves for the electron densities by Shajn and by Allen. The curves have approximately the same gradients. The number of all ions is about $n \sim N_e \times 10^{-4}$. The relation with distance is given by $n = (0{\cdot}6 \times 10^{-4})/r^2$; $N_e = (0{\cdot}73r^{-8} + 1{\cdot}8r^{-18})10^4$. For a static corona the relative gradient of the ion density should be 50–100 times greater than for electrons. The ratio of Fe X to Fe XIV is close to one, and does not change with distance from the limb, the temperature over this interval changing between $1{\cdot}14 \times 10^6$ to $0{\cdot}5 \times 10^6$. There will be no self-reversal even for λ5303. A rough computation gives an absorption coefficient of 10^{-19} per ion of Fe XIV. The total number of ions in the line of sight, touching the limb, is 10^{15}. Thus the optical thickness is 10^{-4}. ASTRONOMICAL NEWS LETTER

523.755 : 522.6

36. A new radio method for measuring the electron density in the solar corona. K. E. MACHIN AND F. G. SMITH. Letter in *Nature* [*Lond.*] **168,** 599–600 (*Oct.* 6, 1951).

It is suggested that observations of the critical distance from the solar centre at which the intense radio star in Taurus is occulted by the sun as a function of the wavelength of observation could permit estimation of electron density in the corona even in regions where it is as low as 10^4 cm^{-3}. Elimination of the effects of sunspot radiation, and general solar radiation, is discussed. M. W. OVENDEN

523.77

37. On the limb effect of faint Fraunhofer lines. Z. SUEMOTO. *Proc. Japan. Acad.,* **27,** 88–92 (*No.* 2, 1951).

Measures of 50 faint solar lines at $\cos\theta = 1{\cdot}0$ to 0·2, treated statistically, appear to confirm the author's prediction that strengthening at the limb depends on the rate of decrease of η with depth. D. L. EDWARDS

523.77

38. On line contours in the anomalous regions of the sun. Z. SUEMOTO. *Proc. Japan Acad.,* **27,** 93–8 (*No.* 2, 1951).

Observations in flares and flocculi of H_ε are fitted by a Doppler contour with half-width 0·4 Å. The [H] and [K] line contours are fitted by combining natural damping for the wings with a Doppler core of half-width 0·070 Å. Both suggest an electron temperature of the order of 70 000°. D. L. EDWARDS

523.854

39. The origin of the hot giants, their "rows," and the development of spiral systems. B. A. VORONTSOV-VELYAMINOV. *Astron. J.* [*USSR*] **28,** 43 (*No.* 1, 1951) *In Russian.*

The author believes that he has discovered long, almost straight rows of hot giants in the Milky Way.

Such rows and chains are present in other galaxies. In M 33 they may have a length of 180 parsecs. Remembering that the Milky Way is larger than M 33 the author thinks that in the latter such chains of stars may have lengths of the order of 2 000 parsecs. But these chains or rows are not identical with the elongated spiral formations; in fact, they are sometimes at right angles to the latter. This renders it almost hopeless to find the spiral structure of the Milky Way. The hot giants are relatively young. Hence, the spiral formations of M 101 are younger than those of M 33, etc. These stars probably were formed out of torn pieces of some condensed form of matter roughly arranged along the spiral arms, and having no resemblance to the spherical volumes considered by Ambarzumian. The material out of which the hot giants are formed may be either in the nature of infrared stars, interstellar dust, or gas.

ASTRONOMICAL NEWS LETTER

523.87

40. Observation of a line in the galactic radio spectrum. I. Radiation from galactic hydrogen at 1 420 Mc/sec. H. I. EWEN AND E. M. PURCELL; **II. The interstellar hydrogen line at 1 420 Mc/sec, and an estimate of galactic rotation.** C. A. MULLER AND J. H. OORT. *Nature* [*Lond.*] **168,** 356–8 (*Sept.* 1, 1951).

The line due to transitions between the hyperfine doublet of the H ground-state has been observed in emission. The source appears extended, centred approximately about the galactic plane, with a maximum at 18 hours R.A. The frequency (measured to an accuracy of 5 kc/s) was displaced (due to orbital and solar motion) by 150 kc/s, the shift varying in the expected manner. The indications are that the interstellar gas becomes optically thick at path-lengths of the order of 500 parsecs, and that the spin temperature is about 35°K, compared with an estimated background radiation temperature in this spectral region of 10°K. Exchange with the radiation field, and with the gas-kinetic energy by proton-proton collisions seem to be the most important processes of energy exchange, the estimated spin relaxation time for these processes being the order of 10^5 years. Emission from the direction of the centre of the galaxy, where galactic rotation does not affect the line, indicates a random velocity in one dimension for the clouds of 5 km/sec. Measures of line width across the Milky Way at galactic longitudes 30° and 355° indicate a galactic rotational velocity, at half the solar distance from the galactic centre, of 190 km/sec. The increased intensity in the Cygnus region may be ascribed to the effects of galactic rotation.

M. W. OVENDEN

523.877

41. On the evolution of stars of the main sequence. V. S. SOROKIN AND A. G. MASEVICH. *Astron. J.* [*USSR*] **28,** 21 (*No.* 1, 1951) *In Russian.*

It is assumed that the stars evolve along the main sequence as a consequence of corpuscular loss of mass until they reach the parameters of the sun. Thereafter the evolution follows the "quiet" pattern of transformation of H into He. The evolutionary path of a star in the L, R diagram is shown.

ASTRONOMICAL NEWS LETTER

523.877

42. The law of loss of stellar mass, deduced from the theory of the internal structure of the stars. A. G. MASEVICH. *Astron. J.* [*USSR*] **28,** 36 (*No.* 1, 1951) *In Russian.*

In a previous paper [Abstr. 5465 (1950)] the form of the relation $dM/dt = kL$ was deduced, on the assumption that the stars between O8 and G4 are constrained to follow the empirical mass-luminosity relation. A more detailed study is made here of this relation and of the time-intervals involved, when the exponent of the $L = M^n$ relation is varied. The result is $n = 3{\cdot}9$, in good agreement with the observations. The star starts its evolution when $M = 14{\cdot}2\ M\odot$, $X = 0{\cdot}88$. It loses mass at the average rate of $0{\cdot}151\ M\odot$ per 10^6 years until its mass is $4{\cdot}88\ M\odot$. This is regarded as satisfactory because in Wolf–Rayet stars the loss of mass is observed to be about 100 times greater. The subsequent evolution is much slower. The star loses only $0{\cdot}0064\ M\odot$ per 10^6 years until its mass is $2{\cdot}53\ M\odot$. The computed loss for one solar mass is $0{\cdot}07\ M\odot$ per 10^9 years.

ASTRONOMICAL NEWS LETTER

523.877

43. An empirical temperature scale fixed by the mass-luminosity relationship. II. K. PILOWSKI. *Z. Astrophys.*, **29,** 162–72 (*No.* 2, 1951) *In German.*

For Pt I, see Abstr. 47 (1951).

523.877

44. Methods of deriving radiation-temperature scales: a comparison of their results, and an enquiry into their premises. K. PILOWSKI. *Astron. Nachr.*, **279,** 145–56 (*April*, 1951) *In German.*

A critical comparison of the work of W. Becker, Kuiper and the author. Empirical relationships between radiation temp., radiometric colour-indices and rel. spectra lintensity distribution (cf. mean for 8 GO stars) for the main-sequence stars are discussed.

D. R. BARBER

523.877

45. Turbulence in thermally-stable layers in star-interiors. F. SCHMEIDLER. *Astron. Nachr.*, **279,** 231–6 (*Aug.*, 1951) *In German.*

A theoretical discussion of energy exchanges in stellar atmospheres. Effects of a possible turbulent exchange of matter within a thermally stable zone are reviewed, and a functional dependence of the exchange-coefficient on temp. gradient is found.

D. R. BARBER

523.877

46. Remark on the foregoing paper. L. BIERMANN. *Astron. Nachr.*, **279,** 237 (*Aug.*, 1951) *In German.*

523.877 : 523.841.11

47. Propagation of spherical shock waves in stellar interiors. Z. KOPAL AND C. C. LIN. *Proc. Nat. Acad. Sci., Wash.*, **37,** 495–506 (*Aug.*, 1951).

Novae outbursts are discussed in terms of shock waves originating in the interior of white sub-dwarfs. Previous investigations [Abstr. 3300, 6714 (1951)] have been concerned with particular stellar models whose properties do not approximate closely the expected internal structure of pre-novae. The problem is now approached by reducing the fundamental hydrodynamical and energy equations to a

form suitable for numerical integration over a finite characteristic mesh, boundary conditions being given over two moving surfaces. The mass of a sub-dwarf is regarded as sufficiently small to justify the neglect of radiation pressure, and radiative equilibrium is assumed in front of the shock wave since the effects of radiative breakdown would not make themselves felt in the early stages of an outburst. The results of numerical integrations are to be reported later.

R. A. NEWING

525.35

48. Seasonal fluctuations of the earth's rotation and compensation of the exchanges of momentum between the atmosphere and the earth. F. H. VAN DEN DUNGEN, J. F. COX AND J. VAN MIEGHEM. *Bull. Acad. Roy. Belge Cl. Sci.*, **37**, 427–35 (*No.* 5, 1951) *In French.*

Based on the work of V. P. Starr the order of magnitude of the monthly mean values of seasonal fluctuation of the earth's rotation are obtained using the hypothesis of a uniform perfect compensation in the exchange of momentum between the atmosphere of the two hemispheres and the earth. It is shown that the rotation of earth exceeds the mean in March–August and is less August–March. The flux of momentum across the equator southwards has its maximum Nov.–Feb. and minimum June–Sept. The exchange of momentum between the atmosphere and the earth and between the atmospheres of the two hemispheres is greatest when the speed of rotation of the earth is least and vice versa. In February the resultant flux is from earth to atmosphere and in August in the reverse direction. R. S. READ

529

49. The accurate measurement of time. D. BROUWER. *Physics Today*, **4**, 6–15 (*Aug.*, 1951).

A discursive review, based on historical foundations, but giving an account of the most recent work both by astronomical observations and laboratory clocks.

529.786

50. Atomic clocks and frequency stabilization on microwave spectral lines. C. H. TOWNES. *J. Appl. Phys.*, **22**, 1365–72 (*Nov.*, 1951).

Application of the various types of radiofrequency spectral lines to accurate frequency stabilization and time standards is surveyed. Pertinent characteristics of microwave gas absorption lines and the various types of errors in frequency stabilization due to the nature of these absorption lines or to fundamental thermal noise are discussed in detail. It is shown that time standards synchronized with microwave absorption in ammonia or resonances in molecular or atomic beams have limits of accuracy of the order of 1 part in 10^{12} for a short time, and still smaller limiting fractional errors over longer periods of time. A.

PHYSICS 53

53

51. The Harvard Case Histories in experimental science: the evolution of an idea. J. W. SHIRLEY. *Amer. J. Phys.*, **19**, 419–23 (*Oct.*, 1951).

This is a discussion of the fundamental ideas behind the Case Histories prepared for use in a general education course at Harvard University. A limitation upon the results achieved in this programme by lack of integration with other fields is pointed out. Integration of natural science with the humanities, social sciences and biological sciences is established as a goal for general education. Lack of maturity among college students defeats in many cases the attainment of the goal, making necessary a whole-hearted effort to have the interrelations of the various fields constantly stressed in all. A.

53.075, 542.2

52. Further laboratory and workshop notes. [Ed.] RUTH LANG. *London, Edward Arnold & Co.* (1951) *pp.* x + 290, 177 *illustrations.*

Further notes selected from *J. Sci. Instrum.* which have appeared mainly during the last 5 years. [See Abstr. 3739 (1949)]. Chapters: Graphs and drawings. Optical devices and techniques. Devices for liquids and gases. Heat, thermometry and furnaces. Laboratory and workshop tools, processes and devices. Vacuum and pressure techniques and devices. Electrical devices and ancillary equipment and techniques.

FUNDAMENTALS 530.1

530.12

53. On the structure of space-time and the physical notion of time in a static gravitational field. J. BECQUEREL. *C.R. Acad. Sci.* [*Paris*] **233**, 590–3 (*Sept.* 10, 1951) *In French.*

The space-time interval between neighbouring events for an observer moving with a particle is expressed in terms of the co-ordinates of an observer at rest relative to the centre of spherical symmetry of a gravitational field. Assuming Newtonian acceleration, and postulating the equality of inertial and gravitational mass, it is shown that the methods of special relativity indicate a metric of the Schwarzschild form. R. A. NEWING

530.12

54. Volkoff's massive spheres. A. K. RAYCHAUDHURI. Letter in *Phys. Rev.*, **84**, 166 (*Oct.* 1, 1951).

A static spherically symmetric line element is interpreted as a particle of negative mass at the centre of a sphere of positive density; for a given density there exist upper and lower limits to the proper radius.

R. A. NEWING

530.12 : 531.18

55. The continuum in special relativity. B. LEAF. *Phys. Rev.*, **84**, 345–50 (*Oct.* 15, 1951).

A relativistically covariant formalism describing the behaviour of a continuous medium is presented. A

method is developed for resolving covariant expressions into space and time components. One obtains by this method from a symmetric energy-momentum tensor, a scalar invariant energy density, a vector heat flux, and the stress tensor. The laws of thermodynamics appear as time components and the laws of dynamics as space components of the same relativistic equations. If the divergence of the energy-momentum tensor vanishes, then the first law of thermodynamics and Newton's second law of dynamics (including thermal effects) follow. Reversible processes are considered, and the second law of thermodynamics is formulated with the use of scalar invariant temperature and entropy. A.

530.145

56. Classical mechanics as a transformation theory. H. TIETZ. *Z. Naturforsch.*, **6a**, 417–20 (*Aug.*, 1951) *In German.*

An elementary proof is given that a Hamiltonian theory may be completely described by canonical transformations. R. H. DALITZ

530.145

57. On the notion of a physical system. P. DESTOUCHES-FÉVRIER. *C.R. Acad. Sci.* [*Paris*] **233**, 604–6 (*Sept.* 10, 1951) *In French.*

Composition is regarded as an observable that can be represented as an integer, and not as an intrinsic property of a system. If the prime numbers 2, 3, 5, . . . are associated one with each of various types of elementary particles, the integer $n = 2^a 3^b 5^c \ldots$ would represent a system containing a particles of the 1st type, b of the 2nd, etc. An evolutionary operator is introduced satisfying an integral equation. R. A. NEWING

530.145 : 536.75

58. Information, measurement, and quantum mechanics. J. ROTHSTEIN. *Science*, **114**, 171–5 (*Aug.* 17, 1951).

A function giving a measure of the quantity of information carried by a message has been called the entropy in communication theory. A short history of the concepts of entropy and information is presented and the connection between physical and informational entropies discussed; the logical identity of the problem of measurement and that of communication is demonstrated. Various implications in physical theory and the possible relevance of generalized entropy for biology are considered as well as some paradoxes and questions of interpretation in quantum mechanics. The paper concludes with some general observations regarding reality, causality and the completeness of quantum mechanics. F. E. HOARE

530.145

59. Contributions to the study of several points in Feynman's theory. A. VISCONTI. *J. Phys. Radium*, **12**, 726–34 (*July–Aug.–Sept.*, 1951) *In French.*

The evolution operator is systematically studied and shown to satisfy the integral equation of Feynman [Abstr. 243 (1950)], here interpreted in terms of virtual scattering of de Broglie waves. Positron theory and the action formulation of quantum mechanics are also discussed. R. H. DALITZ

530.145

60. The unitary field equations and their approximations. M.-A. TONNELAT. *C.R. Acad. Sci.* [*Paris*] **233**, 513–16 (*Aug.* 13, 1951) *In French.*

The three unitary field theories proposed earlier by the author [Abstr. 8494 (1951)] and based on a non-symmetric metric, are examined under the hypothesis that the antisymmetric part is small enough for neglect of higher than 2nd powers. In each case the gravitational potentials satisfy the equations of general relativity, though the e.m. potentials satisfy equations different from the Maxwell equations. R. H. DALITZ

530.145

61. The electromagnetic equations deduced from a unitary field theory. M.-A. TONNELAT. *C.R. Acad. Sci.* [*Paris*] **233**, 555–7 (*Aug.* 27, 1951) *In French.*

Examines the e.m. equations derived from the author's unitary field theories (see preceding Abstr.) when 3rd and higher powers of the e.m. field are neglected. R. H. DALITZ

530.145

62. On a classical model of an elementary particle. A. VISCONTI. *C.R. Acad. Sci.* [*Paris*] **233**, 852–4 (*Oct.* 15, 1951) *In French.*

Studies a mechanical model for a particle described by the equations of subtractive field theory, the set of associated mesons being regarded as analogous to a compressible fluid whose deformation may represent, for example, a self-oscillation of the particle. R. H. DALITZ

530.145

63. The mathematics of second quantization. J. M. COOK. *Proc. Nat. Acad. Sci.* [*Wash.*] **37**, 417–20 (*July*, 1951).

Summarizes a rigorous study of field operators as transformations in Hilbert space, investigating their mathematical properties. The formalism is given a physical interpretation illustrated by derivation of the Yukawa potential and of Maxwell's equations. R. H. DALITZ

530.145

64. On the Green's functions of quantized fields. I. J. SCHWINGER. *Proc. Nat. Acad. Sci.* [*Wash.*] **37**, 452–5 (*July*, 1951).

The propagation functions for Dirac, Kemmer and Maxwell fields are derived from the author's dynamical principle basic to the theory of fields [Abstr. 6731 (1951)]. The "two-particle" Green's function for the Dirac field is also discussed. R. H. DALITZ

530.145

65. On the Green's functions of quantized fields. II. J. SCHWINGER. *Proc. Nat. Acad. Sci.* [*Wash.*] **37** 455–9 (*July*, 1951).

Continues from the preceding abstract. The boundary conditions characterizing the Green's functions associated with vacuum states on the space-like surfaces in the author's quantum dynamical principle [Abstr. 6731 (1951)] are determined and the mass, polarization and interaction operators occurring in the defining equations for the Green's functions are constructed by a method of successive approximations, distinct from perturbation theory but depending on the smallness of the coupling of the interacting fields. R. H. DALITZ

530.145

66. The methods of second quantization and of configuration space in the relativistic theory of systems of particles. IV. Derivation of the equation of Tamm–Dancoff type for the deuteron. M. JEAN. *C.R. Acad. Sci.* [*Paris*] **233,** 573–5 (*Sept.* 5, 1951) *In French.*

For Pt III, see Abstr. 7519 (1951). The Tamm–Dancoff equation for the deuteron [Abstr. 6264 (1950)] is obtained going from 2nd quantization to configuration space after the covariant elimination of the first-order meson-nucleon interactions. It is emphasized that this procedure requires weak coupling.

R. H. DALITZ

530.145

67. The methods of second quantization and of configuration space in the relativistic theory of systems of particles. V. Derivation of the Bethe–Salpeter equation. M. JEAN. *C.R. Acad. Sci.* [*Paris*] **233,** 602–4 (*Sept.* 10, 1951) *In French.*

The Bethe–Salpeter two-particle equation is derived, to second order, from covariant field theory, after definition of a two-particle Green's function generalizing the Feynman–Dyson S_F function.

R. H. DALITZ

530.145

68. Some notes on multiple-boson processes. R. J. GLAUBER. *Phys. Rev.*, **84,** 395–400 (*Nov.* 1, 1951).

Methods of calculation with nonlinear functions of quantized boson fields are developed during the discussion of two problems involving multiple boson processes. In the first of these a simple treatment is given of the multiple radiation of photons by classical current distributions, a special case of which, in effect, is the infrared catastrophe. In the second illustration, generalizations of the scalar and pseudoscalar meson theories are considered in which the interaction Hamiltonian depends exponentially on the meson field. In the pseudoscalar case such Hamiltonians are closely related to the familiar form of pseudovector coupling. Assuming the over-all coupling of the nucleon and meson fields to be weak, calculations are made of the nuclear forces, and of the multiple production of mesons in meson-nucleon and in nucleon-nucleon collisions. In the latter events statistical independence of meson emissions is found to prevail. A.

530.145

69. On the supplementary condition in quantum electrodynamics. S. N. GUPTA. Letter in *Proc. Phys. Soc.* [*Lond.*] *A,* **64,** 850–2 (*Sept.*, 1951).

The supplementary condition in the interaction representation is obtained in a straightforward way, both for the conventional theory and for the modified condition of the author's treatment [Abstr. 6997 (1950)] of the longitudinal part of the e.m. field.

R. H. DALITZ

530.145

70. Gauge-independent quantum electrodynamics. F. J. BELINFANTE AND J. S. LOMONT. *Phys. Rev.*, **84,** 541–6 (*Nov.* 1, 1951).

A covariant, but not manifestly covariant, form of quantum electrodynamics is discussed. No gauge-dependent potentials are introduced as independent (canonical) variables. Only the transverse electromagnetic field is quantized as a photon field. The theory is formulated first in interaction representation, although only flat space-like surfaces σ are considered. An interaction operator is then used for describing Lorentz transformations (rotations of σ) as well as time dependence (parallel progress of σ). The integrability of the generalized Schrödinger equation is then proved. With transformation to Heisenberg representation the electron wave function ψ loses its spinor character and the transverse photon field $\mathfrak{E}$, $\mathfrak{B}$ its tensor character, but by adding the Coulomb field $\mathbf{E}_{11}$ to $\mathfrak{E}$ the tensor character of the electromagnetic field is restored. The gauge-independent quantum electrodynamics of Pauli's *Handbuch* article is a special form of the result thus obtained for the particular case that the number of electrons is known and finite. The theory has a more general form allowing use of positron (hole) theory. A.

530.145

71. A variational principle for gauge-independent electrodynamics. F. J. BELINFANTE. *Phys. Rev.*, **84,** 546–8 (*Nov.* 1, 1951).

A new Lagrangian for the Maxwell field is defined, expressed completely in terms of gauge-independent transverse field-strengths ($\mathfrak{E}$, $\mathfrak{B}$) and matter variables ($\mathbf{x}_i$, $\mathbf{v}_i$ and $\mathbf{p}_i$ in the classical theory; ψ and $\psi^\dagger$ in the wave-mechanical theory). The Coulomb field is defined in terms of matter variables, and a (solenoidal) vector potential is defined in terms of the magnetic field strength $\mathfrak{B}$. The variational principle gives the usual equations of motion and field equations. Quantization leads automatically to the formulae of gauge-independent quantum electrodynamics. A.

530.145

72. On the value of renormalization constants. W. E. THIRRING. Note in *Z. Naturforsch.*, **6a,** 462–3 (*Aug.*, 1951) *In German.*

The modified propagation function S_F' is estimated for large momenta, and the sum of vacuum polarization graphs obtainable from the simplest vac. pol. graph by electron self-energy insertions is shown to be finite and not expansible in powers of e.

R. H. DALITZ

530.145

73. Applicability of the renormalization theory and the structure of elementary particles. S. SAKATA, H. UMEZAWA AND S. KAMEFUCHI. Letter in *Phys. Rev.*, **84,** 154 (*Oct.* 1, 1951).

The condition is discussed that a set of interacting fields should form a closed system with respect to the renormalization programme, i.e. that this should eliminate all divergences. G. J. KYNCH

530.145

74. On a phenomenological neutron-proton interaction. H. FESHBACH AND J. SCHWINGER. *Phys. Rev.*, **84,** 194–203 (*Oct.* 15, 1951).

Describes the calculations and results obtained in fitting a phenomenological interaction to the properties of the deuteron and related low energy phenomena. This interaction is a linear combination of a central and tensor potential, where both potentials are of the Yukawa shape, but with different ranges.

The calculations were based on the variation-iteration method which has the advantage of providing systematically improved trial wave functions, together with limits of error for the well depth eigenvalue at every stage of the process. The nonpositive definite character of the tensor potential complicates the nature of the convergence to the correct eigenvalue. Special methods are described to overcome this difficulty. The successive iterations were performed numerically on the Harvard Mark I calculator. The accuracy obtained for the well depth parameter was limited in practice by the finite intervals employed in the numerical integration, and is estimated to be one in 10^4. The quadrupole moment, as a nonstationary quantity, does not exhibit the same degree of convergence; the accuracy obtained was here estimated as one in 10^3. The results are presented in tabular form as values of the well depth parameter and of the quadrupole moment for four central potential ranges, five tensor ranges, and three values of the tensor strength. These tables also include values of the fractional amount of D state and of the effective triplet range. The experimental magnitudes of the latter quantities serve to delimit the permissible values of the tensor range. The photoelectric cross-section of the deuteron is shown to involve only the triplet effective range in addition to the familiar zero-range formula. The cross-section for photomagnetic capture contains the singlet and triplet phenomenological parameters, and in addition, a mixed effective range which also includes the effect of an exchange magnetic moment. The value of the mixed range, as inferred from the experimental capture cross-section, agrees with the average of the singlet and triplet effective ranges, within the rather large experimental uncertainties. For the energy domain in which it is appreciable, the photomagnetic cross-section is almost uniquely fixed by the capture cross-section. The comparison of these cross-sections with experiment is satisfactory. A.

530.145

75. Variational scattering theory in momentum space. I. Central field problems. W. KOHN. *Phys. Rev.*, **84**, 495–501 (*Nov.* 1, 1951).

Variational principles for scattering problems in a central field are formulated in momentum space and studied in detail. The method allows of generalization to collisions of composite particles, including disintegrations, into more than two end products, which will be discussed in a forthcoming paper. A.

530.145

76. On the covariance of physical field equations with respect to the Lorentz group. V. VOTRUBA. *Bull. Int. Acad. Tchèque Sci.*, **47**, 79–90 (1946) *In French.*

Shows how to express any Lorentz-covariant quantity in spinor notation. The quasi-Maxwellian set of 8 vector equations due to Frenkel [*Wave Mechanics, Advanced general theory*, p. 266 (1934)] and Madelung [*Z. Phys.*, **54**, 303–6 (*No.* 5–6, 1929)] are written as spinor equations in two ways, which lead to different equations when e.m. field is introduced. Addition of certain supplementary conditions (which are not possible in presence of e.m. field) reduces one set to the Dirac equations. R. H. DALITZ

530.145

77. Theory of dibaric particles. J. S. PEASE. Letter in *Phys. Rev.*, **84**, 167 (*Oct.* 1, 1951).

These are obtained by the fusion of two spin $\frac{1}{2}$ particles of different mass, and satisfy a de Broglie type of equation. G. J. KYNCH

530.145

78. Lagrangian *S*-matrix. W. K. BURTON. Letter in *Phys. Rev.*, **84**, 158 (*Oct.* 1, 1951).

An elegant derivation of the S-matrix as an expression in $\mathfrak{L}^I$, based on Schwinger's Lagrangian formulation of field dynamics [Abstr. 6731 (1951)], the total Lagrangian being $\mathfrak{L} + \mathfrak{L}^I$ and the basic states referring to the system $\mathfrak{L}$. R. H. DALITZ

530.145

79. New aspects of the pseudoscalar meson theory. L. L. FOLDY. Letter in *Phys. Rev.*, **84**, 168 (*Oct.* 1, 1951).

A canonical transformation has been found which transforms pseudoscalar coupling into a non-linear pseudovector coupling together with some additional non-spin-dependent terms. A non-relativistic Hamiltonian is given which is amenable to standard methods of solution. G. J. KYNCH

530.145

80. On the relativistic pseudoscalar meson theory of the deuteron. M. M. LÉVY. *Phys. Rev.*, **84**, 441–7 (*Nov.* 1, 1951).

The existence of stationary states of the neutron-proton system is discussed on the basis of a two-particle Dirac equation, including a retarded pseudoscalar interaction. This interaction (in which the possibility of creation of nucleons pairs is disregarded) is treated according to two different models: in the first one, the negative energy states of each nucleon are supposed to be filled, and the interaction is limited to transitions between positive energy states only; in the second model, which is the generalization of the "one-particle" theory, the negative energy states are considered as empty. It is shown that, in both cases, no stable stationary state exists with such an interaction. A.

530.145 : 537.13

81. Fredholm structures in positron theory. M. NEUMAN. Letter in *Phys. Rev.*, **83**, 1258 (*Sept.* 15, 1951).

The set of operators $\{\Delta_n(e)\}$ whose matrix elements are determinantal representations of the nth particle parts of the S-matrix is isomorphic with $\{D_n(e)\}$ whose matrix elements are nth Fredholm minors constructed on K^F, the kernel of the integral equation for a quantized Dirac field interacting with an external e.m. field. Here $\Delta_0(e)$ and $D_0(e)$ are considered in some detail and $\Delta_0(e) \doteq D_0(e)$ expressed explicitly in terms of K^F. R. H. DALITZ

530.145

82. Bound states in quantum field theory. M. GELL-MANN AND F. LOW. *Phys. Rev.*, **84**, 350–4 (*Oct.* 15, 1951).

The relativistic two-body equation of Bethe and Salpeter is derived from field theory. It is shown that the Feynman two-body kernel may be written as a sum of wave functions over the states of the system.

These wave functions depend exponentially on the energies of the states to which they correspond and therefore provide a means of calculating energy levels of bound states. A.

530.145

83. Discrete energy levels of a nonlinear oscillator. J. H. MORAN. *J. Appl. Phys.*, **22**, 1355–8 (*Nov.*, 1951).

Following a brief survey of the theory, especially Eckweiler's work, of nonlinear oscillators satisfying an equation of the form $(d^2q)/(dt^2) + \varepsilon F(dq/dt) + q = 0$ a special case is considered for which the stable limit cycles have a definite relation to one another and to the so-called Planck oscillator. A nonlinear "quantum effect" is discussed and shown to be similar to the harmonic quantum oscillator in some respects. No physical model is proposed for which the equation considered would be a description but various possibilities in this regard are indicated. A.

530.145

84. A note on the quantum-mechanical perturbation theory. P.-O. LÖWDIN. *J. Chem. Phys.*, **19**, 1396–1401 (*Nov.*, 1951).

The solution of the quantum-mechanical eigenvalue problem is discussed for cases when a series of approximate eigenfunctions is known. If these "unperturbed" states are divided into two classes, a perturbation formula is derived giving the influence of one class of states on the other in the final solution. The formula contains as special cases: (i) the Schrödinger–Brillouin formula for the eigenvalue of a non-degenerate state, (ii) a new simple formula for treating a class of degenerate states, and (iii) the splitting of the secular equation in cases where the system naturally consists of two independent parts in mutual interaction. A.

530.162

85. On the statistical treatment of systems of many particles. R. BECKER. *Z. phys. Chem.*, **196**, 181–7 (*Sept.*, 1950) *In German.*

A critical discussion of current methods in statistical mechanics. In particular, the difference between average values and most probable values is pursued in some detail. P. T. LANDSBERG

530.162

86. The Hausdorff measure of the curve of Brownian motion in *n* dimensions. P. LÉVY. *C.R. Acad. Sci.* [*Paris*] **233**, 600–2 (*Sept.* 10, 1951) *In French.*

Upper bounds for the measure are obtained, and it is shown that the Hausdorff measure of order 2 is zero. N. L. JOHNSON

530.162

87. Quantum corrections to transport properties at high temperatures. J. DE BOER AND R. B. BIRD. Letter in *Phys. Rev.*, **83**, 1259 (*Sept.* 15, 1951).

It is shown that transport properties at temperatures where the quantum correction is small may be calculated conveniently by the use of expressions due to Chapman and Cowling and collision phase shifts obtained by W.K.B. methods. J. R. MADDOX

530.162 : 519.2

88. Stochastic methods in statistical mechanics. G. W. KING. *Nat. Bur. Stand., Appl. Math. Ser.*, *No.* 12, 12–18 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. Describes an investigation, using punched cards machines, of the effect of allowing for excluded volume on the number of possible complexions of the Meyer tetrahedral lattice model for high polymers. The properties of high polymers with long chain molecules can be studied by applying the theory of Markoff chains to a sequence of about 20 links "sliding" along the molecule.

N. L. JOHNSON

MECHANICAL MEASUREMENTS 531.7

531.753 : 621.318.387

89. An electromagnetic weight-loader for fine balances. G. F. HODSMAN AND E. R. BROOKE. *J. Sci. Instrum.*, **28**, 348–51 (*Oct.*, 1951).

A method of applying known variable forces to the swinging beam of a fine balance by using the repulsion between a metal plate upon the beam and an adjacent rigidly mounted coil carrying alternating current. Weight-loading up to 10 mg has been achieved with an accuracy of about 0·2 mg. The application of the method to a two knife-edge balance is described and an extension to the three knife-edge balance is mentioned. A.

MECHANICS OF FLUIDS 532

532.12

90. The temperature variation of the compressibility of molten sodium. T. E. POCHAPSKY. *Phys. Rev.*, **84**, 553–8 (*Nov.* 1, 1951).

The present method for the determination of the adiabatic compressibility depends in the first instance upon the measurement of the velocity of propagation of a short train of ultra-high frequency compressional acoustic waves in the material. This figure is then combined with the best available value of the density to yield the compressibility, on the assumption that the rigidity of the liquid is zero. The wave trains are produced and detected by a piezoelectric transducer, and the resultant signal is exhibited on the screen of an oscilloscope whose sweep circuit is time-calibrated to permit the measurement of the transit time of a train over a known path length in the medium. A novel acoustic interferometer is employed, with which small changes in velocity can be measured with high precision. The velocity of compressional waves in molten Na at the freezing point, 97·6°C, is 252 600 $\pm$ 500 cm/sec, and its temperature coefficient remains constant at the value $-52{\cdot}4 \pm 0{\cdot}3$ cm/sec °C at least to 545°C. The adiabatic compressibility is $16{\cdot}85 \times 10^{-12}$ cgs at 97·6°C, and its temperature coefficient increases from $0{\cdot}012 \times 10^{-12}$ cgs at this temperature to $0{\cdot}013 \times 10^{-12}$ cgs at 545°C. The relations between these quantities and other elastic and thermal properties of solid and liquid sodium are discussed. A.

532.12 : 534.21

91. The effect of sound waves on the ascending velocity of air bubbles in viscous liquids. H. NØDTVEDT. *Beretn. Michelsens Inst. Vidensk.*, **12**, 13 *pp.* (*No.* 5, 1948).

Small-scale experiments have shown that the properties of very viscous liquids (e.g. molten glass or Canada balsam) are changed if sound energy is introduced. In the present work it is shown that air bubbles in Canada balsam ascend with a velocity up to four times that of the original state when the sound energy is about 0·05 watt/cm² at a frequency of 9·3 kc/s. Clusters of small bubbles collapse into one larger bubble under the influence of sound waves. A. B. WOOD

532.133

92. Viscosity of neopentane. M. K. PHIBBS. *J. Chem. Phys.*, **19**, 1420–1 (*Nov.*, 1951).

The viscosity has been measured between −15°C and 30°C. These results are consistent with published work covering the temperature range 30°C to 150°C. The data have been compared with similar data for the other pentanes, providing an example of the importance of molecular shape for viscosity behaviour. The possible significance of molecular shape for the interpretation of viscosity curves of binary mixtures is noted. A.

532.51

93. Boundary layer in convergent flow between spiral walls. G. KUERTI. *J. Math. Phys.*, **30**, 106–15 (*July*, 1951).

If the two-dimensional, steady-flow problem in boundary layer theory is formulated in terms of the stream function, ψ, the corresponding differential equation is $\nu\nabla^2\nabla^2\psi = \psi_y\nabla^2\psi_x - \psi_x\nabla^2\psi_y$, and of this equation only one particular solution is known to converge towards boundary flow when ν (the viscosity) $\to 0$, viz., Hamel's convergent (sink) flow between radial walls [*Jber. dtsch Math. Verein.*, **25**, 34–60 (1916)]. The radial flow problem is a particular case of a family of solutions of the above equation in which the stream lines are logarithmic spirals. A sink flow between spiral walls belongs to this family, and the question posed is whether the solution of the boundary layer problem in this case can be obtained as the asymptotic form of Hamel's solution. It is shown that it can be so deduced, for any width of spiral channel, and for any degree of obliqueness of the spiral streamline except when the spiral degenerates into a circle. J. S. G. THOMAS

532.528

94. Effect of surface condition of a sphere on its water-entry cavity. A. MAY. *J. Appl. Phys.*, **22**, 1219–22 (*Oct.*, 1951).

An investigation of factors which influence the formation of a cavity when a sphere enters water vertically is described. It was found that cavities are formed at much lower entry speeds for contaminated spheres than for clean ones, but that there is little dependence on the type of the contaminant. In regard to the scaling effect, the tendency to form a cavity varies little with change of size or specific gravity of the sphere. Water-entry cavities are observed to form at velocities much lower than those required for incipient cavitation in the water tunnel; consequently, a relation between the two effects appears improbable. Some dependence of cavity formation on viscosity might be inferred from the observation that cavities were formed at lower entry speeds by spheres coated with liquids of high viscosity than by spheres without this coating. A.

532.59 : 538.566 : 519.283

Wave propagation in hydrodynamics and electrodynamics. *See Abstr.* 26

CAPILLARITY 532.6

532.612

95. On Gibbs theory of surface tension. T. L. HILL. Letter in *J. Chem. Phys.*, **19**, 1203 (*Sept.*, 1951).

A discussion of curved surfaces starting with macroscopic independent variables, the introduction of a dividing surface being avoided. T. C. TOYE

532.612.4

96. Surface tension of liquid metals. N. R. MUKHERJEE. Letter in *J. Appl. Phys.*, **22**, 1215–16 (*Sept.*, 1951).

The surface tension of liquid metals near the melting point is found to be proportional to the molar latent heat of fusion. T. C. TOYE

532.62

97. C. V. Boys' rainbow cup and experiments with thin films. J. SATTERLY. *Amer. J. Phys.*, **19**, 448–51 (*Nov.*, 1951).

Describes experiments on thin films that can be done easily with Boys' rainbow cup, mounted on a phonic wheel to insure constancy of rotational speed. Although the air within the cup, on one side of the film, has free access to the atmosphere on the other side of the film, the film itself is spherical. A quantitative explanation of the effect is given in terms of Bernoulli's principle. A.

532.696.1 : 539.4.01

98. Experimental researches on "wetting effect" and "liquostriction." C. BENEDICKS AND R. HÄRDÉN. *Ark. Fys.*, **3**, 407–40 (*Paper* 22, 1951).

"Wetting effect" is the change in the tensile strength of a solid when the surface is "wetted" by various liquids. "Liquostriction" is the change in volume of a solid caused by "wetting" of the surface by a liquid. In both cases no ordinary chemical action takes place. Experimental results are given showing the magnitude of the "wetting effect" for a series of solids and liquids, e.g. for quenched steel the bending tensile strength decreases when the surface is wetted by Ethanol, octanol and water (20%), but is increased by tar oil, kerosene (25%), decalin. In the case of liquids which decrease the tensile strength the change is, approximately, inversely proportional to the surface tension. Results are also given for experiments to measure the "liquostriction" of quartz fibres and various metal wires, e.g. for quartz fibre 0·037 mm dia. wetted by water $\Delta l/l \times 10^6 = 5{\cdot}7$. Iron wire dia. 0·051 mm gives a value of 10. J. IBALL

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

99. On the theory of coherent scattering processes in liquids. L. GOLDSTEIN. *Phys. Rev.*, **84**, 466–75 (*Nov.* 1, 1951).

The coherent scattering structure factor of liquids for X-rays and slow neutrons are shown to determine completely both the correlation function and the direct local interaction function of liquids, which quantities are the only operating elements of the general static liquid model of Ornstein and Zernike. Of these functions only the former has been derived so far from the data accumulated essentially on the coherent scattering of X-rays by liquids. It is shown that the directly available experimental structure factors completely determine the even moments of these molecular distribution functions. The zeroth moment of the correlation function augmented by unity is essentially the liquid concentration fluctuation which determines its isothermal compressibility. These quantities become thus directly derivable from the structure factor measurements without any arbitrary and uncertain manipulations. In terms of the model, a straightforward method leads, with the empirically obtainable total cross-section, to the total incoherent slow neutron scattering cross-sections in liquids. These should yield information on their energy spectrum not available through other types of scattering processes, such as X-rays, for instance. A.

532.7 : 534.22

100. Molecular kinetic theory of the speed of sound in liquids. W. SCHAAFS. *Z. phys. Chem.*, **196**, 397–412 (*Feb.*, 1951) *In German.*

The previous conclusion of the author's that the speed of sound in organic liquids is proportional to the volume occupied by the molecules is generalized, by showing that it is also proportional to a collision factor which depends on the extent to which the collisions between the molecules are elastic. The dependence of the speed of sound on the intermolecular forces and on temperature has also been discussed. P. T. LANDSBERG

532.7 : 534.22

101. The addition rules for the speed of sound in liquids. W. SCHAAFS. *Z. phys. Chem.*, **196**, 413–26 (*Feb.*, 1951) *In German.*

Previous calculations (preceding Abstr.) are extended. There is a detailed comparison between calculated and observed speeds of sound in organic liquids at 20°C. P. T. LANDSBERG

532.7 : 534.22

102. A study of the velocity of ultrasonics in fluids in the region of the critical point. J. NOURY. *C.R. Acad. Sci.* [*Paris*] **233**, 516–18 (*Aug.* 13, 1951) *In French.*

Results are given of measurements made at 950 kc/s on N_2O and CO_2 along the isotherms in the neighbourhood of the critical state. G. F. HODSMAN

532.7 : 534.23

103. Elastic relaxation and structure of liquids. I. Ultrasonic absorption in some halogenated methylenes, ethanes, and ethylenes. D. SETTE. *J. Chem. Phys.*, **19**, 1337–41 (*Nov.*, 1951).

In order to obtain information on the presence of structural effects in the elastic relaxation phenomena observed in liquids, the ultrasonic absorption was studied as a function of temperature in some organic compounds whose structure is correlated in a simple way. Large differences of absorption coefficient and of its temperature dependence have been found. It is difficult, at the present time, to understand clearly the results, but they show that the liquid structure has a great importance in the relaxation phenomena present in liquids. Moreover, an increase in dipole moment of the molecules is often present with an increase of absorption, showing that the dipole moment is not related in a simple way with the characteristics of relaxation phenomena and that all the interactions among the molecules are to be taken into account. A.

532.7 : 534.23

104. On the elastic relaxation in carbon disulfide: the temperature dependence of the ultrasonic absorption coefficient. D. SETTE. *J. Chem. Phys.*, **19**, 1342–4 (*Nov.*, 1951).

A measurement was performed at 30 Mc/s. The value obtained for α is in agreement with the higher values of the absorption coefficient obtained by other authors at various frequencies and, therefore, it gives credence to them in comparison with others. The absorption coefficient as a function of temperature does not follow a linear law as it does in other unassociated liquids. The temperature coefficient $(1/\alpha)(\partial\alpha/\partial t)$ goes from $7{\cdot}3 \times 10^{-3}$ deg^{-1} at -23°C to almost zero near the boiling point. These results can be used to examine the theoretical explanations of absorption in CS_2 based on the assumption that all the vibrational modes relax together or on the hypothesis that they have different relaxation times. The value of the temperature coefficient at 25°C seems to be better explained with the first treatment. A.

532.72 : 539.16

105. Self-diffusion and structure of liquid water. II. Measurement of self-diffusion of liquid water with O^{18} as tracer. J. H. WANG. *J. Amer. Chem. Soc.*, **73**, 4181–3 (*Sept.*, 1951).

For Pt I, see Abstr. 5160 (1951). In order to correct for the possible errors involved in the measurement of self-diffusion of liquid water with D as tracer reported earlier, the self-diffusion coefficients of liquid water have been redetermined with O^{18} as tracer between 1° and 55°. Results of the present measurements confirm the earlier conclusion that no definite species of associated water molecules exist in liquid water, and that liquid water actually possesses a semi-crystalline structure which changes only very little between 5° and 55°. Comparison with earlier measurements with D as tracer shows that special mechanisms of H-atom transfer, such as those similar to that which occurs in the electrolytic conduction by H ion, are absent in the self-diffusion of liquid water. The activation energy for self-diffusion with $H_2^1O^{18}$ as tracer is slightly smaller than that with $H_2^2O^{16}$ as tracer, which is what one should expect because of the higher degree of co-ordination in H_2^2O than in H_2^1O. Comparison of

the self-diffusion coefficients obtained in the present work with dielectric and viscosity data shows that Eyring's transition-state theory of rate processes is a fair description of the self-diffusion, viscous flow and dipole orientation for liquid water, and that these three processes involve essentially the same activation mechanism. A.

532.73

106. Isothermal convection flow of the aqueous solution of $KMnO_4$. B. Baranowski. Letter in *Naturwissenschaften*, **38**, 405–6 (*No.* 17, 1951) *In German.*

Describes the sinking of a $KMnO_4$ solution through a column of pure water along a vertical cylinder of uniform diameter; the sinking rate decreases as the temperature rises; after some time the concentration at the bottom can be several times higher than at the top. F. LACHMAN

532.73

107. Compressibilities of concentrated metal ammonia solutions. R. H. Maybury and L. V. Coulter. Letter in *J. Chem. Phys.*, **19**, 1326–7 (*Oct.*, 1951).

Velocity of sound measurements, carried out in concentrated solutions of sodium, lithium, calcium and potassium iodide in ammonia show a rapid increase of compressibility with concentration. An attempt at an explanation, based on a large equilibrium inter-complex distance, is supported by the observed large volume expansion of the solutions on preparation. T. C. TOYE

532.73

108. Conformal solution theory and dipole interaction. J. A. Barker. Letter in *J. Chem. Phys.*, **19**, 1430 (*Nov.*, 1951).

An application of the theory of conformal solutions [Abstr. 2427 (1951)] to a solution in which weak dipole interaction occurs. T. C. TOYE

532.73 : 534.22

109. Ultrasonic velocity in potassium chloride solutions in the region of their negative viscosities. S. Prakash, P. N. Saxena and A. M. Srivastava. Letter in *Nature* [*Lond.*] **168**, 522–3 (*Sept.* 22, 1951).

The viscosity of KCl solutions of $< 6\%$ concentration is anomalously low. Ultrasonic measurements (0·6–2·5 Mc/s) show that sound velocity is also anomalous in this region. R. O. DAVIES

532.73 : 534.23

110. Absorption of sound in aqueous solutions of electrolytes. K. Tamm and G. Kurtze. Letter in *Nature* [*Lond.*] **168**, 346 (*Aug.* 25, 1951).

The absorption of sound in a number of electrolytes of varying concentrations at different temperatures has been measured over a range of frequencies. In general it is found that the presence of a uni-univalent salt in solution does not appreciably alter the absorption while the presence of a bi-bivalent salt has a marked effect. T. C. TOYE

532.73 : 534 : 312.9

111. Experiments on the ultrasonic unmixing of liquid solutions. C. A. Boyd and R. J. Zentner. Letter in *Phys. Rev.*, **83**, 1059 (*Sept.* 1, 1951).

Experiments have been made to show that the unmixing of solutions such as glycerine dissolved in water can be caused by producing standing ultrasonic wave patterns in the liquid. The tests were made at 400 kc/s using an oscillator having an output of 500 W and a solution of 50% by weight of glycerine dissolved in water. Schlieren photographs showed a zone of different refractive index in front of the reflector plate, and analysis indicated an increase of about 6% in the glycerol content in this area. The back of the reflector was then coated with lamp black, and, with the ultrasonic generator not in use, the reflector was heated locally by focusing light on to it—this heating caused a similar change of glycerol content. It seemed, therefore, that the separation of solutions in the ultrasonic tests was caused by secondary thermal effects due to ultrasonic local heating.

A. C. WHIFFIN

532.73 : 536.7

112. Thermodynamic calculation of solubilities under high pressures. H. Gehlen and H. Dieter. *Z. phys. Chem.*, **196**, 258–77 (*Dec.*, 1950) *In German.*

Solubilities have been calculated for high pressures from available data for ordinary pressures and compressibilities. There is satisfactory agreement with experiment. P. T. LANDSBERG

532.73–2

113. On cooperative orientation effects in binary liquid mixtures. A. Münster. *Z. phys. Chem.*, **196**, 106–26 (*Sept.*, 1950) *In German.*

A statistical theory of binary liquid mixtures, one component being subject to cooperative orientation. The most important result of the theory appears to be that the additional term in the expression for the entropy of mixing (which describes the deviations from an ideal solution) is positive, and thus in agreement with experiment. Previous theories yielded a negative correction term. P. T. LANDSBERG

MECHANICS OF GASES 533

533.15

114. On the pressure-dependence of the thermodiffusion factor. R. Haase. *Z. phys. Chem.*, **196**, 219–34 (*Dec.*, 1950).

533.15

115. Self diffusion in CO_2 at moderate pressures. K. D. Timmerhaus and H. G. Drickamer. *J. Chem. Phys.*, **19**, 1242–3 (*Oct.*, 1951).

Diffusion data are presented for the system CO_2–$C^{14}O_2$ over a pressure range from 0·50 to 28·1 atmospheres. Within the accuracy of the data, agreement is obtained with the diffusion theory of Enskog and Chapman, using the Lennard–Jones model. A.

533.15

116. Diffusion as hydrodynamic motion. M. H. Johnson. *Phys. Rev.*, **84**, 566–8 (*Nov.* 1, 1951).

A phenomenological definition of diffusion in a binary mixture suggests a description of the motion by a hydrodynamic equation which contains a frictional force proportional to the relative diffusion velocity. Plausible assumptions give a set of hydrodynamic equations for any gaseous mixture, which may include

charged molecules in a magnetic field. The equations determine the diffusion velocities in terms of the applied forces, the pressure gradients, and the binary diffusion coefficients. The same equations are also derived from kinetic theory in the first diffusion approximation. In higher approximations where thermal diffusion first appears, the equations are no longer valid. A.

533.21 : 535.437

117. The prediction of isothermal compressibilities by light scattering. L. G. BLOSSER AND H. G. DRICKAMER. *J. Chem. Phys.*, **19**, 1244–6 (*Oct.*, 1951).

Light transmission measurements have been made on ethane, and on a mixture of methane and propane near the critical point, using the 4 050, 4 360 and 5 460 Å lines from a mercury lamp. Isothermal compressibilities have been calculated. This appears to be a considerably more accurate method than the use of p-v-t data for the prediction of compressibilities near the critical point. A.

533.21, 536.71

118. The compressibility of gaseous xenon. I. An equation of state for xenon and the weight of a liter of xenon. J. A. BEATTIE, R. J. BARRIAULT AND J. S. BRIERLEY. *J. Chem. Phys.*, **19**, 1219–21 (*Oct.*, 1951).

The compressibility of Xe containing 0·14 mole % of Kr has been measured from 16·65° (the critical temperature) to 300°C and over the density range 1 to 10 mole per litre. The constants of the Beattie–Bridgeman equation of state for the sample used and for pure Xe have been determined from these measurements. The constants for pure Xe are $R = 0{\cdot}08206$, $A_0 = 4{\cdot}6715$, $a = 0{\cdot}03311$, $B_0 = 0{\cdot}07503$, $b = 0$, $c = 30{\cdot}02 \times 10^4$ in units of normal atmos. litre per mole, and °K (T°K $= t$°C $+ 273{\cdot}13$). The weight of one litre of Xe at a pressure of one standard atmosphere is calculated from its molecular weight (131·3) and the above parameters to be 5·897 g per litre at 0°C and 5·467 g per litre at 70°F. A.

533.21, 536.71

119. The compressibility of gaseous xenon. II. The virial coefficients and potential parameters of xenon. J. A. BEATTIE, R. J. BARRIAULT AND J. S. BRIERLEY. *J. Chem. Phys.*, **19**, 1222–6 (*Oct.*, 1951).

The 2nd and 3rd virial coefficients of Xe have been determined from compressibility measurements over the temperature range 16·65° (the critical temperature) to 300°C. The parameters of the Lennard–Jones (6, 12) potential for Xe are $\mu = 5{\cdot}583 \times 10^{-58}$ erg-cm^6, $\lambda = 2{\cdot}514 \times 10^{-102}$ erg-cm^{12}, $\varepsilon = 309{\cdot}9 \times 10^{-16}$ erg, $b_0 = 84{\cdot}65$ cm^3 per mole, $\theta = 224{\cdot}5$°K, $\sigma = 4{\cdot}064 \times 10^{-8}$ cm, $r_0 = 4{\cdot}561 \times 10^{-8}$ cm. The representation of the 2nd virial coefficient is quite satisfactory. The 3rd virial coefficients agree moderately well with the theoretical values for the Lennard–Jones (6, 12) potential tabulated by Bird, Spotz and Hirschfelder for $(T/\theta) > 1{\cdot}5$ but diverge rapidly as the temperature approaches the critical. The observed 2nd virial coefficients agree moderately well with the values tabulated by Buckingham and Corner for an inverse 6th power attractive and an exponential repulsive potential when the calculated values are read from the table for the parameters given by Kane from data on the solid state of Xe and from Born and Mayer's value of the exponent derived for Ne. A.

533.5

120. Experiments with metal foils as high-vacuum seals. H. HINTENBERGER. *Z. Naturforsch.*, **6a**, 459–62 (*Aug.*, 1951) *In German.*

Design and use of dismountable, heatable metal (especially Al) foil vacuum seals for flange connections, in which a ring-shaped foil is compressed between an annular knife edge on one and a corresponding groove in the other flange. Al foil seals between brass flanges remain vacuum-tight up to 280°C. G. WITTENBERG

533.6.01

121. Drag of a finite wedge at high subsonic speeds. J. D. COLE. *J. Math. Phys.*, **30**, 79–93 (*July*, 1951).

A method of determining an approximate expression for the pressure drag at a finite wedge of unit length and of semi-angle δ, in a perfect non-viscous gas, at subsonic stream Mach number $\simeq 1$ is discussed. It is shown how the drag arises from the completely subsonic portion of the front part of the wedge. The drag curve predicted from transonic theory has the correct general form and slope at $M_\infty = 1$ (M_∞ denoting the Mach number at up-stream infinity), and agrees fairly well with the few experimental determinations available. The same type of drag occurs at supersonic speeds when there is a detached shock wave ahead of the wedge. The drag, computed from two-dimensional theory, is of the nature of the upper limit drag on wings of finite span. The drag coeff. predicted for a 10° wedge ($\delta = 5$°) is large. Closing the wedge at the rear may reduce this drag somewhat, at least for low Mach numbers. It is shown how shock waves can be fitted into a basically-subsonic flow pattern satisfying the boundary conditions. J. S. G. THOMAS

533.6.01

122. On aerophysics research. R. J. SEEGER. *Amer. J. Phys.*, **19**, 459–69 (*Nov.*, 1951).

Deals with the scope of the borderline field between aerodynamics and physics, which has become known as aerophysics. It emphasizes the desirability of utilization of ballistics ranges for aerophysics investigation. In this connection, it reviews in outline form the history of ballistics. Examples of aerophysical research are cited from aeroballistics (high speed gas flows) investigations. A.

533.6.01

123. The response of an aerodynamic system under external harmonic force. H. SERBIN. *J. Appl. Phys.*, **22**, 1307–15 (*Nov.*, 1951).

The theory of nonconservative linear systems of a finite number of degrees of freedom is presented. An expression is derived for the response of the system to external harmonic forces. The effect of small variations in parameters is obtained and there is a discussion of the influence of an additional degree of freedom. A numerical procedure is given for the calculation of characteristic roots and vectors and the results are applied to a numerical example. A.

533.6.011.5

124. Characteristics method for the approximate calculation of unsymmetrical supersonic flow past ring-shaped bodies. W. HAACK. *Z. angew. Math. Phys.*, **2**, 357–75 (*Sept.*, 1951) *In German.*

The supersonic flow of an ideal gas past an inclined slender body of revolution, can be approximately determined by linearization of the differential equations. For this purpose generally a distribution of sources, sinks and doublets is taken (von Kármán, Moore, Tsien). For a composed body of revolution having a central body and several rings, this procedure is cumbersome. It is shown that such flows can very simply be determined by means of a characteristics-method. Surface discontinuity and their multiple reflection on the walls do not present much difficulty. The method is illustrated by some simple examples. It is to be mentioned that the method can be extended also to the general, not linearized, differential equations. A.

533.6.011.5 : 534.222.2

125. On the structure of the compression shock. K. ZOLLER. *Z. Phys.*, **130**, 1–38 (*No.* 1. 1951) *In German.*

In a previous treatment by Becker [*Z. Phys.*, **8**, 321 (1922)] the contributions of viscosity and thermal conductivity to the equations of conservation of mass, momentum and energy through a stable plane shock wave were expressed in terms of only the first derivatives of the velocity and temperature of the gas-flow. In the present treatment, the viscosity and thermal conductivity are derived from the kinetic theory of a gas consisting of point-masses having an inverse-fifth-power law of repulsion; this is equivalent to expressing the viscosity and thermal conduction terms in the conservation equations as an infinite series of derivatives and their cross-products. The effects of 2nd-order derivatives and the cross-products of 1st-order derivatives have been taken into account in numerical solutions carried out for pressure-ratios $p_1/p_0 = 1{\cdot}5$, $4{\cdot}0$ and $6{\cdot}5$ (where p_1 is the pressure behind the shock and p_0 the pressure before the shock). These calculations show that the thickness of the shock-front for $p_1/p_0 = 4{\cdot}0$–$6{\cdot}5$ is 2–3 times as large as would be expected on Becker's theory. It is pointed out, however, that for $p_1/p_0 = 6{\cdot}5$, and to a lesser extent for $p_1/p_0 = 4{\cdot}0$, the results are somewhat unreliable, because in these cases the effects of higher-order derivatives may not be negligible; but the computational labour involved in dealing with derivatives higher than second-order becomes prohibitive. A. SCHOFIELD

533.6.011.5 : 534.222.2

126. A new method for the production of air shocks in a tube. A. B. LAPONSKY AND R. J. EMRICH. Letter in *J. Appl. Phys.*, **22**, 1297 (*Oct.*, 1951).

A piston accelerated from rest at 10^4 m/sec^2 for a distance of 1 m initiates in air a shock wave appearing within 10 m of the initial piston position. This technique is particularly suitable for investigations of the growth and formation of shock waves, and is being applied in such an investigation, using a pneumatically-impelled 50 g piston in a 3·5 cm dia. shock-tube. A. SCHOFIELD

533.6.013.22

127. Erratum: On the spectrum of isotropic temperature fluctuations in an isotropic turbulence. S. CORRSIN. Letter in *J. Appl. Phys.*, **22**, 1292 (*Oct.*, 1951). See Abstr. 4170 (1951).

MOLECULAR THEORY OF GASES 533.7

533.7

128. Single scattering of molecules in a gas with a Maxwell distribution. J. W. HIBY AND M. PAHL. *Z. Phys.*, **129**, 517–29 (*No.* 5. 1951) *In German.*

This is calculated for a molecular beam scattered by a gas of the same molecular weight and the same Maxwell distribution of velocities. A classical hard-sphere model is used. The results agree with the experimental results of von Knauer [*Z. Phys.*, **80**, 80 (1933)] and Zabel [*Phys. Rev.*, **44**, 53 (1933)].

G. J. KYNCH

533.7

129. Barometric pressure formula and Maxwell's velocity distribution law. F. LANDT AND R. LEHNERT. *Z. phys. Chem.*, **197**, 247–55 (*Aug.*, 1951) *In German.*

The barometric pressure formula has been obtained for a one-dimensional homogeneous gas under gravity, and it has been shown that Maxwell's velocity distribution law follows from it. P. T. LANDSBERG

533.7 : 536.7

130. Remarks about the theory of evaporation ratios. K. NEUMANN. *Z. phys. Chem.*, **196**, 16–22 (*Sept.*, 1950) *In German.*

A theoretical investigation of the influence of specific models on the resulting expression for the rate of evaporation. Existing models have been discussed and generalized, and the relation with formulae which are based on consideration of the condensation process has been pointed out.

P. T. LANDSBERG

VIBRATIONS . ACOUSTICS 534

534.154 : 621.317.39

131. Measurement of the amplitude of very small mechanical vibrations. H. DEVÈZE. *J. Phys. Radium*, **12**, 723–6 (*July–Aug.–Sept.*, 1951) *In French.*

A brass probe, 25 cm long by 4 mm dia., carrying a rider to adjust its natural frequency of vibration, is placed against the vibrating body. The other end of the probe is attached to a quartz-crystal pick-up carried upon a micrometer screw, the body of the micrometer being firmly supported. The output of the pick-up, and the air-borne waves of vibration received on another pick-up, are fed to an oscillograph, the auxiliary pick-up being used to detect when the probe interferes with the vibration of the body under test. In this way, the amplitude of the vibration is measured on the micrometer to an accuracy of 0·1 μ. A. C. WHIFFIN

534.22/.23 : 532.7

Velocity and absorption of sound in liquids. *See Abstr.* 100–4

534.222

132. The effect of small cavities on the velocity of sound in metals. F. GATTO. *Alluminio, No.* 1, 19–26 (1950) *In Italian.*

The various frequencies of longitudinal resonance are determined for specimens of cylindrical form. Observations are made of the variation of the fundamental frequency of longitudinal resonance and of the mass of the specimen when it contains a pair of symmetrically placed transverse holes at various distances from the centre of the test-piece. The change of frequency divided by the frequency for a solid specimen is divided by the ratio of the change of mass to the original mass; and this quantity K is shown to decrease with increase of the distance between the hole and the centre of the specimen (falling from 3 at zero distance to -1 when the holes are nearly at the extremities of the specimen. Increase of the number of transverse holes affects the value of K, while it is reduced by increase of the ratio of the diameter of the hole to the space between them.

A. C. WHIFFIN

534.23

133. Absorption coefficient and impedance of a system of resonators at oblique incidence. R. K. VEPA. *Electrotechnics, No.* 23, 50–5 (*March*, 1951).

An expression for the acoustic impedance of the system of resonators formed by a perforated sheet with rigid backing, at oblique incidence, is derived. The absorption coefficient is deduced from its value at normal incidence using a modified definition of characteristic impedance. G. D. SIMS

534.23

134. The effect of partitions in the absorptive lining of sound-attenuating ducts. U. INGÅRD AND D. PRIDMORE-BROWN. Letter in *J. Acoust. Soc. Amer.*, **23,** 589–90 (*Sept.*, 1951).

Attenuation measurements made in a duct fitted with cross-wise partitions have shown that the optimum arrangement has a spacing of $\lambda/2$ at the resonance frequency of the material. G. F. HODSMAN

534.232

135. On a special aspect of ultrasonic emission. E. GROSSETTI. *Nuovo Cim.*, **8,** 441–5 (*July*, 1951) *In Italian.*

Curves show the relationship between the angle of the direction of the collimated radiation from a Navapour lamp with respect to the surface of a quartz ultrasonic emitter (dimensions, $2{\cdot}8\times1{\cdot}8$ cm; frequency, 1·8 Mc/s) and the intensity of the corresponding diffracted ray system, with one face of the emitter in contact with H_2O, paraffin oil, aq. glycerol or ethyl polyglycol. Calculated and experimental results agree well, except for the glycol. The curves are all symmetrical and have a marked minimum at the angle 0°. J. GRANT

534.242

136. Sound waves test cylinder heads. *Electronics*, **24,** 90–1 (*Oct.*, 1951).

All cavities within a specific type of throat opening have a natural sonic resonant frequency. Furthermore, if a master cavity is used for comparison with an unknown cavity and the two are made to resonate at their natural frequencies, then the frequency difference is a measure of the volume difference, volume being $\propto 1/f^2$. By exciting the cavity with a sound source derived from a transducer which in turn is energized by an oscillator, the cavity can be made to resonate and the output from a microphone embedded in the cavity wall rise sharply at this point. In an automatic application of this technique to motor-car engines, the cylinder-head blocks are slid upside down on to a fixture table adjacent to a master head. The requisite number of sonic piston throats, transducers and microphones—according to the number of cylinders—are connected in turn by means of a stepper selector switch to an oscillator and discriminator. The natural frequency of each cavity is then compared in turn with that of the master cavity in the discriminator. If within tolerance, the switch automatically moves on to the next cavity: if not, the switch stops and a signal light operates. Six-cylinder heads can be inspected at a rate of $\sim$ 180/hr.

H. G. M. SPRATT

534.26

137. Scattering of plane waves by soft obstacles. II. Scattering by cylinders, spheroids, and disks. E. W. MONTROLL AND R. W. HART. *J. Appl. Phys.*, **22,** 1278–89 (*Oct.*, 1951).

For Pt I, see Abstr. 4312 (1951). Approximate closed-form analytical expressions are derived for the total and differential scattering cross-sections of cylindrical, prolate spheroidal and disk-shaped scatterers which subject scalar plane waves to only a small phase shift. When a plane wave excites a sphere or infinite cylinder, the internal field of these objects can be expressed as an infinite series of Bessel functions. By making an approximation in coefficient of the nth Bessel function which is valid for either $2\pi a/\lambda_0 \gg n$ (a = sphere or cylinder radius, λ_0 = wavelength of incident plane wave) or $|m-1| \ll 1$ ($m = \lambda_0/\lambda_1$, λ_1 = wavelength of plane wave in medium composed of material of scatterer), it is possible to obtain a closed form expression for the series. The scattered field is obtained by integrating over these internal fields. The scattered fields for long but finite cylinders and prolate spheroids are calculated by approximating their internal fields by those of infinite cylinders of the same radius. The scattered fields of thin disks are obtained by assuming the internal fields to be of an infinite flat plate of the same thickness. A.

534.26 : 535.42

138. On the diffraction of scalar plane waves by a slit of infinite length. S. SKAVLEM. *Arch. Math. Naturv.*, **51,** 61–80 (*No.* 1–2, 1951).

Diffraction by a narrow, infinitely long slit is treated by Bouwkamp's method of partial waves, and solutions are found for the two boundary conditions $\psi = 0$ and $\partial\psi/\partial n = 0$, the latter being appropriate for acoustic problems. Numerical values of the transmission coefficients are tabulated for both conditions as functions of the parameter $k = 2\pi a/\lambda$, a being the half-breadth of the slit. For acoustic waves, $t \to \infty$ as $k \to 0$, so that a very narrow slit

relatively transmits an exceptionally high amount of sound energy. R. W. FISH

534.37 : 533.6.011.3

139. Acoustic streaming and the conservation of angular momentum. P. J. WESTERVELT. Letter in *Phys. Rev.*, **84**, 152 (*Oct.* 1, 1951).

An expression is derived for the rate at which angular momentum is transferred from an acoustic wave to a medium in which losses occur, this transfer generating time-independent vorticity. The streaming velocity is calculated from the transfer of angular momentum, the rate at which angular momentum is transferred from the wave to the medium being balanced by stresses arising from the streaming of the fluid. A. C. WHIFFIN

534.372

140. On damping by the radiation of elastic waves and on damped vibrations of a bar. F. GASSMANN. *Z. angew. Math. Phys.*, **2**, 336–56 (*Sept.*, 1951) *In German.*

Deals with a bar (called "oscillator"), clamped in a finite or infinite body (called "support") and excited to vibrations. The loss of kinetic energy of the oscillator has been divided into three kinds, i.e. (*a*) "inner damping" described by a suitable generalization of Hooke's law, (*b*) "outer damping," due to frictional forces acting at the free surface of the oscillator, and (*c*) "damping by radiation" caused by the elastic waves, radiating from the surface of contact between the oscillator and the support and travelling through the latter. As examples of supports, a semi-infinite bar and the infinite-elastic space have been treated. As examples of vibrations, forced harmonic longitudinal, transverse and torsional vibrations of the bar have been considered. A.

534.372

141. Vibration absorbing system for the galvanometer. P. JOHANNIN. *J. Rech. Cent. Nat. Rech. Sci.*, **3**, 343–4 (*No.* 15, 1951) *In French.*

An anti-vibration galvanometer support is described. The galvanometer rests on a spongy rubber pad on the top of the upper of two horizontal metal plates which are independently supported by vertical rods 100 and 90 cm long respectively from a base plate. Between the two plates and linking them there is a viscous oil damping system. The periods of vibrations of the loaded upper plate and of the lower plate are of the order of 2 and 1/3 sec respectively. S. WEINTROUB

534.372

142. Comments on the Johannin absorber. Theory of its function. H. GONDET. *J. Rech. Cent. Nat. Rech. Sci.*, **3**, 345–50 (*No.* 15, 1951) *In French.*

A theoretical, mainly mathematical, discussion of the Johannin anti-vibration stand [see preceding Abstract.] S. WEINTROUB

534.44 : 621.395.62 : 621.317.79

143. An 8 000-cycle sound spectrograph. O. GRUENZ. *Bell Lab. Rec.*, **29**, 256–61 (*June*, 1951).

Designed primarily for the study of speech, the instrument gives either narrow-band (90 c/s) or broad-band (2 kc/s) spectrograms, which are recorded by stylus on a chart. The layout of the apparatus used is described, together with other possible applications for which the wide bandwidth is an advantage. G. F. HODSMAN (R)

534.511 : 621.395.645

144. Demonstrating harmonics and beats. R. C. HITCHCOCK. *Amer. J. Phys.*, **19**, 445–7 (*Nov.*, 1951).

A group of 10 fixed-frequency audio oscillators having frequencies related by $100(N)$, where N is an integer, are used. Details of construction of oscillators, audio amplifier, and associated power supply are given. With the oscillators it is possible to demonstrate production of synthetic 1st and 2nd harmonics by playing 2 or more tones simultaneously. Five characteristic tones may be played simultaneously to simulate a bell-like tone. A.

534.6 : 621.395.645 : 621.317.39

145. Equipment for acoustic measurements. I. A portable general purpose microphone amplifier using miniature valves. D. E. L. SHORTER AND D. G. BEADLE. *Electronic Engng*, **23**, 326–31 (*Sept.*, 1951).

This mains-driven amplifier is designed to work into and out of a 600 Ω load and to give a max. output of 400 mW for 0·5% distortion. Other features are the provision of an independent output for a monitoring loudspeaker, a visual indication of output level, and the ability to transmit short-duration pulses. The amplifier consists of: (1) a first stage with the gain variable by altering the neg. feedback in two 10 db stages; (2) a special carbon-track attenuator; (3) a 3-valve line amplifier with push-pull output; (4) another similar amplifier low-impedance output for the monitoring loudspeaker; (5) a peak programme meter operated from (4); and (6) a light-weight power pack. The attenuator consists of a block of resistive material with its underside covered with conducting material which constitutes the common input-output connection. The dimensions of the block are such that, when the input is applied to one end and the output taken from the sliding contact in the usual manner, the unit behaves as an artificial line and the attenuation in db is $\propto$ the slider displacement over a wide range. The frequency response is approx. flat from 30 c/s to 10 kc/s. Design details and characteristic curves are given. The carrying case measures $17 \times 10 \times 6$ in^3 and the weight of the complete instrument is 18 lb. H. G. M. SPRATT (R)

534.844.5

146. The use of artificial reverberation in theatre speech. A. MOLES. *Ann. Télécommun.*, **6**, 245–9 (*Aug.–Sept.*, 1951) *In French.*

Optimum speech intelligibility requires a low reverberation time but in the theatre a higher value is sometimes necessary for artistic reasons. The two can be reconciled by means of artificial reverberation with auxiliary echo room. The relation between intelligibility and the slope of the decay curve is given and checked by experiments. G. F. HODSMAN

534.862.3

147. Recording studio design. P. A. SHEARS. *Wireless World*, **57**, 355–60 (*Sept.*, 1951).

The principle defects of such studios are variation

of reverberation time with frequency, standing waves and flutter echoes. Curves show optimum and max. permissible reverberation times for studios of various sizes while formulae enable these intervals to be determined in terms of the studio dimensions and the areas of sound-proofing material purposely introduced. Other formulae reveal the frequency of standing waves which, in the case of small rooms, may come within the a.f. band. H.f. damping can be effected by means of textiles or, better still, absorbent tiles and curves of the absorption coeff. *v.* frequency are given for such materials. A cheaper procedure is to employ panels of insulating board and these in fact alone act as resonant absorbers for l.f. Actual designs and curves for such units are provided. Treatment of windows and floors and insulation between the studio proper and an adjacent monitoring room are considered. The complete design of a $20 \times 15 \times 12$ ft^3 studio is worked out.

H. G. M. SPRATT

534.862.3 : 621.317.79

148. The use of Neumann's bathymeter for measuring the quality of gramophone disks. A. MOLES. *Radio Franç., No.* 7–8, 19–22 (*July–Aug.*, 1951) *In French.*

A method of recording the dynamic range of a disk is described. A normal pick-up and amplifier are employed. For the recording meter, however, a valve-voltmeter will have too high a time constant while its voltage range is limited. A c.r.o., on the other hand, has negligible inertia but is difficult to calibrate, difficult to read accurately over a wide amplitude range, and provides no permanent trace. The Neumann bathymeter, which is preferred, consists of an amplifier-detector which is fed from a logarithmic potentiometer and itself feeds an astatic galvanometer. The moving element has at one end a needle recording on a moving paper chart while the other end controls the position of the potentiometer slider so that the meter input remains constant at 10 mV. The potentiometer is fed from the pick-up amplifier. The recorded trace, therefore, is a continuous record of the "dynamic" of the disk on a db scale. The inertia of the instrument is sufficiently low since a recent model can respond to transients having a rate of rise up to 1 000 db/sec. Several traces taken from disks of varying dynamic ranges are illustrated.

H. G. M. SPRATT

OPTICS . RADIATION . SPECTRA 535

535.222

149. A check determination of the velocity of light. E. BERGSTRAND. *Ark. Fys.*, **3**, 479–90 (*Paper* 26, 1951).

Measurements were made in 1950 of the 6 km base line on the island of Öland. The spread of the results obtained on different days was $\pm 2{\cdot}5$ km/s and the final result is given as $299\,793{\cdot}14 \pm 0{\cdot}42$ km/sec. Together with the result obtained in 1949 this gives $c = 299\,793{\cdot}1 \pm 0{\cdot}2$ km/sec.

L. ESSEN

535.23

150. Erratum: The emission of radiation from diatomic gases. I. Approximate calculations. S. S. PENNER. Letter in *J. Appl. Phys.*, **22**, 1298 (*Oct.*, 1951). See Abstr. 7107 (1950).

535.232

151. Thermocouple measurements of spectral intensities in the vacuum ultraviolet. D. M. PACKER AND C. LOCK. *J. Opt. Soc. Amer.*, **41**, 699–701 (*Oct.*, 1951).

The spectral energy distribution of the radiation from a high-intensity H arc, after dispersal by a vacuum monochromator, was measured with a thermocouple in the spectral region 2 600 to 900 Å. An aluminized one-meter concave grating, having a dispersion of 17 Å/mm, was used near normal incidence in the 1st-order spectrum. A thermocouple sensitivity of $1{\cdot}6\ \mu v/\mu w$ was adequate for recording most of the spectrum at a band width of 14 Å. Arrangement of equipment rendered unnecessary the use of windows in front of the thermocouple and end-on H arc. Spectral energies in the many-lined molecular spectrum below 1 700 Å were 5 to 40 times those found in the continuum above 1 700 Å. The results show that it is now possible to extend the range of various energy detectors, calibrated in absolute response, throughout the vacuum ultraviolet down to 900 Å.

A.

535.24

152. Concerning photometry under scotopic conditions. Y. LE GRAND. *Atti Fond. "Giorgio Ronchi,"* **6**, 197–200 (*Aug.*, 1951) *In Italian.*

Discusses the resolutions passed recently by the Commission Internationale de l'Eclairage with regard to photometry under conditions of complete dark adaptation and gives the values assigned to the scotopic relative luminous efficiency of radiation at all wavelengths. It is pointed out that certain anomalies appear if the same name is used for the units in which both scotopic and photopic quantities are expressed.

J. W. T. WALSH

535.242 : 621.317.39 : 628.971

153. An illumination recorder. A. H. TAYLOR AND W. G. PRACEJUS. *Illum. Engng* [*N.Y.*] **46**, 310–13 (*June*, 1951).

Describes a recording illumination photometer which can be mounted on, or towed behind, a car as it travels along a street so as to provide a continuous record of the horizontal or vertical illumination. A photo-voltaic cell, corrected both for cosine-error and for spectral sensitivity, is the sensitive element and the photo-current, amplified so as to obtain 1 mA for an illumination of 1 ft-candle, operates a recorder carried in the car. The method used for calibration, and applications to problems other than street lighting, are described.

J. W. T. WALSH

535.242.6

154. Fluorescent sensitized photomultipliers for heterochromatic photometry in the ultraviolet. F. S. JOHNSON, K. WATANABE AND R. TOUSEY. *J. Opt. Soc. Amer.*, **41**, 702–8 (*Oct.*, 1951).

Photomultipliers sensitized to the extreme ultraviolet by coating with a layer of fluorescent material were found satisfactory for the measurement of

radiation intensities at least down to 850 Å. The relative spectral quantum efficiencies of sodium salicylate, pump oil, anthracene, calcium and cadmium tungstates, and Eastman ultraviolet fluorescing lacquer were measured by comparison against a thermocouple, using a vacuum monochromator. Sodium salicylate was found to be the best suited for sensitizing a photomultiplier, since it had high sensitivity to the extreme ultraviolet and low sensitivity to long wavelength stray light. Heterochromatic photometry can be carried out with this combination, since the quantum efficiency of sodium salicylate was approximately independent of wavelength over the range 900–2 300 Å. The properties of stilbene, phenanthane and several miscellaneous phosphors were also measured. A.

535.247 : 628.9

155. The photometry of projected light. J. M. WALDRAM. *Trans Illum. Engng Soc.* [*Lond.*] **16,** 187–207 (*No.* 8, 1951).

Discusses the measurement of the performance of projection equipment as used for signals, beacons and searchlights, and the methods and equipment used for various classes of projector, in laboratories in different counties. A.

535.31

156. The Seidel aberration terms for systems of thin lenses and mirrors. H. SLEVOGT. *Optik*, **8,** 369–75 (*No.* 8, 1951) *In German.*

The invariant method for the determination of the Seidel coefficients is used to calculate these coefficients in terms of the individual thin lens parameters. The spherical mirror is treated as a special case of a thin lens. R. W. FISH

535.31

157. A simple method for locating principal points. L. EISNER. Note in *Amer. J. Phys.*, **19,** 474 (*Nov.*, 1951).

535.313.2

158. The determination of a three-mirror system consisting of an (arbitrary) paraboloidal mirror and a two-mirror supplementary system, for which spherical aberration is removed and the sine condition (freedom from coma) is strictly fulfilled. Investigation into the substitution of the (deformed) auxiliary mirror by more simply produced mirror surfaces. V–VI. J. PICHT. *Optik*, **8,** 318–34 (*No.* 7); 337–53 (*No.* 8, 1951) *In German.*

Continuation of previous papers [Abstr. 7658 (1951)] applying the results to practical systems for which numerical data are given. R. W. FISH

535.317

159. An algebraic prism formula applicable to lenses. F. MOONEY. Letter in *J. Opt. Soc. Amer.*, **41,** 644–5 (*Sept.*, 1951).

The minimum deviation prism formula is generalized from the Snell equations for the two surfaces. By expansion, the deviation of a ray can be found in a form applicable to lenses, yielding the usual lens formulae. R. W. FISH

535.317

160. Some remarks on ray tracing. M. HERZBERGER. *J. Opt. Soc. Amer.*, **41,** 805–7 (*Nov.*, 1951).

In order to use high-speed calculating machines in ray tracing, it is advisable to replace trigonometrical formulae by formulae involving the solution of quadratic equations. It is shown that the tracing of skew as well as of meridian rays is accomplished by solving two quadratic equations and an iterative process (based on Newton's method) is suggested for solving the equations speedily by machine calculation. A numerical example is given. A.

535.317.4

161. On the final correction of geometrical aberrations. C. MOSER. *J. Opt. Soc. Amer.*, **41,** 727–9 (*Oct.*, 1951).

To facilitate the final correction of an optical system, formulae are developed using the intermediate data obtained by ray tracing. For each aberration the expressions obtained contain constants of the system multiplied by certain partial magnifications corresponding to the different surfaces. The use of such expressions is shown to require much less computation than orthodox methods. It is also shown that in this approach to the problem the optical system can be divided into two parts of which the one contains the focal length of the whole system and the other stands for the state of correction of the whole system. A.

535.317.5

162. A new approach in the analytical study of the spherical aberrations of any order. J. LEFAIVRE. Letter in *J. Opt. Soc. Amer.*, **41,** 647 (*Sept.*, 1951).

The diffraction pattern in the presence of spherical aberration is studied by introducing a variable phase change into a plane wave incident upon an aperture. A new method is suggested for obtaining the expansion of the integral giving the complex amplitude of the emergent wavefront. R. W. FISH

535.317.7

163. New resolving power test chart. F. E. WASHER AND F. W. ROSBERRY. *J. Opt. Soc. Amer.*, **41,** 597–600 (*Sept.*, 1951).

A chart has been made that embodies the features outlined by Gardner. A contact print of this chart is made with the aid of a small distant light source and a specially shaped diaphragm moving over the chart at constant speed. The final test chart has a continuous variation in contrast from one end of the target line to the other. This chart is to be used to determine the variation of resolving power with contrast for a given lens with a single exposure. The long lines of the target make it especially suitable for microphotometric examination of the final test images, thus bringing closer an objective method of determining the resolving power of a photographic lens. A.

535.321.53

164. Phase contrast studies at extremely small refractive differences in liquids. E. INGELSTAM. *Ark. Fys.*, **3,** 387–92 (*Paper* 20, 1951).

Constructional details of a phase contrast apparatus using the Francon–Nomarski phase mirror system are given and the technique of forming the liquid cells is described. Refractive index differences of $0{\cdot}5\times10^{-6}$ are detectable, corresponding to a concentration sensitivity of 0·0002%. The apparatus is calibrated with a standard striae of magnesium fluoride on glass. R. W. FISH

535.33.07

165. Modification of a Beckman model DU spectrophotometer for automatic operation at 210–2 700 mμ. W. KAYE, C. CANON AND R. G. DEVANEY. *J. Opt. Soc. Amer.*, **41**, 658–64 (*Oct.*, 1951).

This improvement has been achieved through replacement of the red-sensitive phototube with a PbS cell, replacement of the ultraviolet-sensitive phototube with an IP28 photomultiplier tube, provision of a rotating, slotted drum to interrupt the light beam, and use of an electronic recorder. The null meter circuit of the spectrophotometer may be used if desired. All of the standard Beckman accessories may be used without modification. In view of the demonstrated resolving power, the robustness and the relative low cost of this modified instrument, it is believed to open a new field for analysis. A.

535.33.07–15

166. A fast-scanning infrared recording spectrometer. P. J. WHEATLEY, E. R. VINCENT, D. L. ROTENBERG AND G. R. COWAN. *J. Opt. Soc. Amer.*, **41**, 665–72 (*Oct.*, 1951).

A spectrometer has been constructed to scan portions of the i.r. spectrum at repetition rates up to 20 spectra per sec. The optics are basically those of a Perkin–Elmer Model 12 C prism spectrometer. The electrically driven mechanical system used to oscillate the Littrow mirror provides for changing the repetition rate, the scanning interval and the spectral region independently of one another while the instrument is in operation. A Golay pneumatic detector with a time constant of 1·2 msec extends the spectral range to 14 microns with a NaCl prism. The resolving power is low by conventional standards, but is satisfactory for broad bands such as those exhibited by gases under high pressure. The spectra are displayed on a cathode-ray oscillograph and are recorded photographically. Reference marks corresponding to definite orientations of the Littrow mirror are obtained by a subsidiary optical system and are indicated as blanked spots on the oscillograph trace. A synchronized radiation beam chopper serves to indicate the zero radiation signal during the unusable portion of the scanning period. The spectrometer was designed for the study of solid propellant flames, but will also be useful for the study of fast, but not explosive, gas reactions. A.

535.33.07–15 : 535.417

167. An interference spectrometer for the infra-red. J. H. JAFFE. Letter in *Nature* [*Lond.*] **168**, 381 (*Sept.* 1, 1951).

A small-gap Fabry–Perot interferometer rotated before the slit of a monochromator leads to an improved resolution. The interferometer used has a 16 cm^{-1} range between orders and resolves rotational structure of the HCl band at 1·76 μ. The reflector used is antimony. S. TOLANSKY

535.33.07–15 : 539.165

168. Film thickness measurements for infrared spectrophotometry. J. H. PETERSON AND J. R. DOWNING. Letter in *J. Opt. Soc. Amer.*, **41**, 862–3 (*Nov.*, 1951).

Measurement of the transmission of β-particles can give the mass per unit area of film. Al and cellophane films have been tried. G. F. LOTHIAN

535.33.07–32

169. Ultraviolet spectral sensitivity characteristics of photomultipliers having quartz and glass envelopes. L. DUNKELMAN AND C. LOCK. *J. Opt. Soc. Amer.*, **41**, 802–4 (*Nov.*, 1951).

The ultraviolet spectral response characteristics of several 1P28 photomultipliers constructed in quartz envelopes, and of conventional 1P28 photomultipliers in glass were measured using a vacuum grating monochromator equipped with a thermocouple for measureing the absolute energy at the exit slit. The radiation source was a hydrogen discharge tube. The quartz multipliers were found to respond to 1 550 Å and the glass multipliers to 1 750 Å. The limits and response near the limits were determined by the absorption of the respective envelopes. Each type responded to a small extent at wavelengths below the envelope transmission limits, because of fluorescence of the envelope. The response at 2 537 Å varied over the same range for both types. A.

535.332 : 551.593.9

The forbidden ^4S–^2D line of neutral N in the spectra of twilight and the night sky. *See Abstr.* 665

535.332 : 551.594.5

O_2^+ and H in the auroral spectrum. *See Abstr.* 671

535.338

170. Vibrational structure of the hydrocarbon flame bands. G. M. MURPHY AND L. SCHOEN. Letter in *J. Chem. Phys.*, **19**, 1214–15 (*Sept.*, 1951).

535.338 : 539.153.4

Configuration interaction in the Pb III spectrum. *See Abstr.* 468

535.338/.343 : 535.33.03

171. Rotational temperatures of OH in methane-air flames. H. P. BROIDA. *J. Chem. Phys.*, **19**, 1383–90 (*Nov.*, 1951).

Rotational line intensity distributions in emission and absorption of the $0 \longleftrightarrow 0$ band of the $^2\Sigma \longleftrightarrow {}^2\Pi$ transition of OH have been measured in methane-air flames. The number of electronically excited OH radicals in the inner cone greatly exceeds the equilibrium concentration, and the intensity distribution of the high quantum numbers gives a temperature of 5 200°K. However, OH radicals in the ground state were in thermal equilibrium at 2 000°K. A break in the intensity distribution indicates a two-stage combustion reaction. It is suggested that the excessive amount of excited OH is due to its formation in the intermediate reaction steps. Line reversal temperatures using Na, Hg and OH have been measured in the same flame for purposes of comparison. Also the rotational temperature of excited OH in a methane-oxygen flame was measured. A.

535.338.333

172. Isotope shift in the Ce II spectrum and the magic number 82. K. MURAKAWA AND J. S. ROSS. Letter in *Phys. Rev.*, **83**, 1272 (*Sept.* 15, 1951).

The upper limit of the distance 138–140 was found to be about half the distance 140–142. This anomaly can probably be ascribed to the stable nuclear structure connected with the presence of 82 neutrons. L. PINCHERLE

535.338.333

173. Isotope effect in the band spectrum of HNO_2. G. PORTER. *J. Chem. Phys.*, **19**, 1278–81 (*Oct.*, 1951).

The band system between 3 100 and 3 900 Å which has been attributed both to HNO_2 and enhanced NO_2 is shown to belong to the former molecule by means of the isotope effect. Measurements of the spectrum of DNO_2, and a partial interpretation of the band structure and isotope shift are given. A.

535.338.333

174. New data on isotope shifts in uranium spectra; U^{236} and U^{234}. D. D. SMITH, G. L. STUKENBROEKER AND J. R. MCNALLY, JR. Letter in *Phys. Rev.*, **84**, 383–4 (*Oct.* 15, 1951).

The position of the 4 244 Å line has been measured with a dispersion of 0·6 Å/mm for the isotopes U^{238}, U^{236}, U^{235}, U^{234} and U^{233}. A. G. GAYDON

535.338.333, 539.152.2

175. Isotope shift in the spectrum of Os I and the magnetic moment of Os^{189}. S. SUWA. Letter in *Phys. Rev.*, **83**, 1258 (*Sept.* 15, 1951).

The hyperfine structure (found with a Fabry–Perot etalon) was assigned to the isotopes 186, 188, 190, 192 and 189 and using the suggested nuclear spin $\frac{1}{2}$ the magnetic moment of Os^{189} was found to be $+0{\cdot}6 \pm 0{\cdot}1$ nucl. magnetons. W. J. SWIATECKI

535.338.4

176. The band systems of thorium oxide and hafnium oxide. S. G. KRISHNAMURTY. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 852 (*Sept.*, 1951).

Examination of the red-degraded bands excited in the arc spectra suggests ω_e'' (HfO) ~ 865, ω_e'' (ThO) $\sim 740\ cm^{-1}$. Multiplet splittings in what are probably $^3\pi$ levels have also been recognized. R. F. BARROW

535.338.4 : 539.152.1 : 539.155.2

177. Band spectra of the selenium isotopes. S. P. DAVIS AND F. A. JENKINS. Letter in *Phys. Rev.*, **83**, 1269 (*Sept.* 15, 1951).

Spectrograms of the $^1\Sigma_u^+ - {}^1\Sigma_g^+$ system of Se_2 using as major components Se^{77}, Se^{78} and Se^{80} have been taken. Study of line-intensities shows that the nuclear spin of Se^{77} is $\frac{1}{2}$. R. F. BARROW

535.338.42 : 539.132

178. Anomalous intensity distribution of rotation lines in fundamental vibration bands in triatomic molecules. H. H. NIELSEN. *Bull. Soc. Roy. Sci. Liège*, **20**, 439–46 (*June–July*, 1951).

Theoretical expressions for the intensities of band-lines are derived. Especially in the case of the fundamental ν_3, the transitions $K \rightarrow K+1$ may, depending on the values of certain molecular parameters, be greatly enhanced at the expense of the transitions $K \rightarrow K-1$. This gives an explanation of the anomalous intensity distribution in the band ν_3 of H_2S at $3{\cdot}8\ \mu$. R. F. BARROW

535.339

179. A monochromator for the vacuum ultraviolet. R. TOUSEY, F. S. JOHNSON, J. RICHARDSON AND N. TORAN. *J. Opt. Soc. Amer.*, **41**, 696–8 (*Oct.*, 1951).

A 1-metre normal incidence vacuum grating monochromator, designed from the points of view of speed in operation, versatility, automatic scanning and photoelectric recording, is described. The instrument is equipped with a three-speed synchronous direct reading wavelength drive, with entrance and exit slit turrets which permit rapid interchange of three slits, and with a fast pumping system. A.

535.34 : 537.312.5

180. Optical absorption and photoconductivity of amorphous and hexagonal selenium. M. A. GILLEO. *J. Chem. Phys.*, **19**, 1291–7 (*Oct.*, 1951).

These properties were studied in their dependence on temperature. The absorption edge shifts for amorphous Se toward shorter wavelengths with decreasing temperature. It can be shown that this shift is related to the thermal excitation of vibration levels. At low temperature (*c.* 90°K) photoconductivity is observed only after the light quanta exceed 2·5 eV and the absorption coefficient has reached $10^5\ cm^{-1}$. Increase of temperature brings about a shift of the photoconductive threshold toward longer wavelengths, paralleling the absorption-edge shift. Its values at the end points of this range are $1{\cdot}6 \times 10^2$ and $5{\cdot}2 \times 10^5\ cm^{-1}$, respectively; there is a slight maximum at 2 600 Å where the absorption coefficient reaches $5{\cdot}6 \times 10^5\ cm^{-1}$. The transformation of amorphous into hexagonal Se by heat brings about an increase of the optical absorption in the 5 000 to 7 200 Å region and the appearance of a distinct hump in the absorption edge at 5 200 Å. In hexagonal Se photoconductivity is observed at wavelengths as long as 7 500 Å for films $0{\cdot}5\ \mu$ thick. A peak in the photoresponse is found where the optical density of these films reaches *c.* 1 (10% transmission). It can be shown that this behaviour is to be expected for a bimolecular law of recombination of electrons and holes when their inhomogeneous distribution is taken into account. A.

535.34

181. Optical absorption of barium oxide with excess barium. E. O. KANE. Letter in *J. Appl. Phys.*, **22**, 1214–15 (*Sept.*, 1951).

Deep red BaO crystals ($0{\cdot}6\ mm^3$) were grown from solution of BaO in Ba. Light absorption by the crystals is temperature-sensitive and may be due to interstitial Ba atoms or O vacancies, a process analogous to *F*-centre absorption in alkali halides taking place. J. A. FRANKS

535.343

182. The absorption spectrum of GaCl. F. K. LEVIN AND J. G. WINANS. *Phys. Rev.*, **84**, 431–40 (*Nov.* 1, 1951).

The absorption spectrum of GaCl has been measured and analysed to provide values for molecular constants. The energy of dissociation for the ground state has been determined from a pre-dissociation limit as less than 5·00 V and probably greater than 4·98 V. A.

535.343–14 : 535.338.334

183. Erratum: The theory of pressure broadening and its application to microwave spectra. M. MIZUSHIMA. Letter in *Phys. Rev.*, **84**, 363 (*Oct.* 15, 1951).

See Abstr. 6850 (1951).

535.343–15

184. Infra-red spectra of the deutero-ethylenes. J. CHARETTE AND M. DE HEMPTINNE. *Bull. Acad. Roy. Belge Cl. Sci.*, **37**, 436–48 (*No.* 5, 1951) *In French.*

The spectra from 500–3 900 cm^{-1} of all the isomers with interpretation. D. H. WHIFFEN

535.343–15

185. A method for the measurement of the intensity of infrared absorption bands. G. AMAT. *C.R. Acad. Sci.* [*Paris*] **233**, 372–4 (*July* 30, 1951) *In French.*

Equations are given in which the maximum energy absorbed at a given wavelength is expressed as a function of the width of the spectrograph slit.

W. R. ANGUS

535.343–15

186. The infrared spectra of $DC^{12}N$ and $DC^{13}N$. W. S. RICHARDSON. Letter in *J. Chem. Phys.*, **19**, 1213–14 (*Sept.*, 1951).

The fundamental infrared frequencies of $HC^{12}N$, $HC^{13}N$, $DC^{12}N$ and $DC^{13}N$ are tabulated. The force constants of $DC^{12}N$ and $DC^{13}N$ are calculated using the respective stretching frequencies. W. R. ANGUS

535.343–15

187. The absorption frequencies of CH and their perturbations. II. Theoretical study. R. CHABBAL AND P. BARCHEWITZ. *J. Phys. Radium*, **12**, 701–9 (*July–Aug.–Sept.*, 1951) *In French.*

For Pt I, see Abstr. 9372 (1951). A theoretical study of the modes of vibration of the oscillators CH_3, CH_2, CH, $CH_2{=}$ and $CH{\equiv}$ is given, and the origins of previously recorded absorption bands are deduced. Equations for the frequencies in terms of the atomic masses and force constants of the bonds involved are given and applied to recorded data.

W. R. ANGUS

535.343–32

188. The vacuum ultraviolet spectrum of allene. L. H. SUTCLIFFE AND A. D. WALSH. Letter in *J. Chem. Phys.*, **19**, 1210 (*Sept.*, 1951).

535.343–32

189. The ultraviolet absorption spectra of some heterocyclic phosphorous compounds. A. FURST AND R. J. HORVAT. *Science*, **114**, 330 (*Sept.* 28, 1951).

Two resonance-hypotheses may explain the high ε max. value of 1-phenylcyclotetramethylenphosphine, treating the compounds as isologues of a substituted aniline, or as partly free radicals. J. JACOBS

535.343.2

190. On absorption spectra [obtained] by reflection from some solid compounds of rare earths. F. BOULANGER. *C.R. Acad. Sci.* [*Paris*] **233**, 650–1 (*Sept.* 17, 1951) *In French.*

Discussion of reflection spectra of hydroxides and aluminates of Nd and Pr, and of Nd oxide.

S. T. HENDERSON

535.343.2–14

191. Microwave spectrum of methyl alcohol. R. H. HUGHES, W. E. GOOD AND D. K. COLES. *Phys. Rev.*, **84**, 418–25 (*Nov.* 1, 1951).

A series of absorption lines of $C^{12}H_3O^{16}H$ which was studied from $J = 2$ to $J = 10$ by Coles has now been followed up to $J = 30$. The corresponding series for $C^{13}H_3O^{16}H$ and $C^{12}H_3O^{18}H$ have been found. The lines of the $C^{13}H_3O^{16}H$ series have been identified and measured from $J = 2$ to $J = 31$ and the lines of the $C^{12}H_3O^{18}H$ series from $J = 2$ to $J = 26$. Accurate Stark-effect measurements have been made of several low J lines of each of the above series and the coefficients tabulated. The frequencies of many other $C^{12}H_3O^{16}H$ lines between 20 000 and 40 000 Mc/s have been measured and tabulated. The order of the Stark effect, quantitative Stark-effect information, and J values of these lines are listed when known. The frequencies of several $C^{13}H_3O^{16}H$ lines which are not members of the above series are listed. A.

535.343.2–15

192. The polarised infrared spectrum of potassium bifluoride at −185°C. R. NEWMAN AND R. M. BADGER. Letter in *J. Chem. Phys.*, **19**, 1207–8 (*Sept.*, 1951).

The polarized infrared spectra of single crystals of KHF_2 at 25°C and −185°C in the range 700–5 800 cm^{-1} are interpreted and vibrational assignments made. A symmetrical linear structure is indicated for the bifluoride ion in this crystal.

W. R. ANGUS

535.343.2–15

193. The infrared absorption and reflection spectra of the ammonium halides. L. F. H. BOVEY. *J. Opt. Soc. Amer.*, **41**, 836–48 (*Nov.*, 1951).

Experimental details for the taking of infrared absorption spectra of thin solid layers at various temperatures are given and a method described for measurement of their thickness. An account of the preparation of suitable samples for reflection spectra is also included. The spectra of the four ammonium halides at 20°C and −150°C have been obtained and the results interpreted in terms of their crystal structure. The data support the following symmetries for the ammonium ion in the low temperature form: (I) T_d in ammonium chloride, (II) V_d in ammonium bromide, (III) V_d in ammonium iodide, and (IV) C_{3v} or C_3 in ammonium fluoride. A.

535.343.32–32

194. The ultraviolet spectra of benzene-halogen complexes and of iodine in solution. J. S. HAM, J. R. PLATT AND H. MCCONNELL. *J. Chem. Phys.*, **19**, 1301–4 (*Oct.*, 1951).

The spectra of the 1 : 1 complexes between benzene and iodine and between benzene and bromine were examined in the wavelength range 2 350–3 500 Å using a 64 micron cell. In both cases a new absorption band was found at 2 600 Å. This band is of considerable theoretical interest in connection with previous discussions of the spectra and structures of the benzene-halogen complexes. Also, the solution spectrum of iodine has been extended to 1 820 Å and the f value compared with predictions. A.

535.343.4 : 541.12

195. Induced infrared absorption of H_2, N_2, and O_2 in the first overtone regions. H. L. WELSH, M. F. CRAWFORD, J. C. F. MACDONALD AND D. A. CHISHOLM. Letter in *Phys. Rev.*, **83**, 1264 (*Sept.* 15, 1951).

Values of the integrated absorption coefficients are given. For H_2, the band-contours suggest that the absorption arises from the superposition of two bands, one $v = 0 \rightarrow 2$ at $2\omega_e - 6x_e\omega_e$, the other corresponding to a double transition at $2\omega_e - 4x_e\omega_e$.

R. F. BARROW

535.343.4–15

196. Quantitative line-width measurements in the infrared. I. Carbon monoxide pressurized with infrared-inactive gases. S. S. PENNER AND D. WEBER. *J. Chem. Phys.*, **19**, 1351–60 (*Nov.*, 1951).

Measurements on CO pressurized with gases such as H_2, He and A have been carried out at room temperature. For pressures up to 100 lb/in² the experimental absorption measurements are correlated quantitatively by the use of theoretical relations derivable from the dispersion formula. Lower limits have been determined for the rotational half-widths of CO broadened by various infrared-inert gases. The determination of rotational half-widths can be refined by allowing for the variation of integrated absorption per rotational line from one line to another in a given vibration-rotation band. With the rotational half-width treated as a variable parameter, a direct comparison between calculated and observed infrared absorption can be used to determine the rotational half-width δ^0 for pressures which are small enough to justify a treatment for non-overlapping rotational lines. A.

535.343.4–15

197. Quantitative line-width measurements in the infrared. II. Unpressurized carbon monoxide. S. S. PENNER AND D. WEBER. *J. Chem. Phys.*, **19**, 1361–3 (*Nov.*, 1951).

Experimental measurements on self-broadening of CO are correlated quantitatively by the use of a dispersion formula for line-shape representation. Interpretation of experimental data in terms of a simplified line-intensity distribution leads to the conclusion that the apparent rotational half-width of CO changes with the pressure of CO at approximately the same rate as with the pressure of H_2 for the fundamental. Similar calculations for the first overtone lead to relatively small values for the apparent rotational half-width. Numerical calculations for a realistic line-intensity distribution have not been carried out. A.

535.343.4–32, 541.14

198. The ultraviolet absorption spectra of gaseous diazomethane and diazoethane. Evidence for the existence of ethylidine radicals in diazoethane photolysis. R. K. BRINTON AND D. H. VOLMAN. *J. Chem. Phys.*, **19**, 1394–5 (*Nov.*, 1951).

The absorption of gaseous diazoethane begins at about 5 400 Å, increases to a broad maximum of $\varepsilon = 3{\cdot}5$ at 4 500 Å and falls to a minimum of $\varepsilon = 0{\cdot}15$ at 3 200 Å. At wavelengths shorter than 3 000 Å a second region of rapidly increasing absorption is found. The absorption curve of diazomethane is similar in general shape to this curve but shifted somewhat toward shorter wavelengths. The absorption of diazoethane is continuous over its entire region while in the visible region diazomethane shows a number of broad and very diffuse bands from about 4 300 Å to 3 200 Å which probably overlie a continuum. The presence of 2-butene in the photolysis products of diazoethane is explained by the combination of ethylidine radicals formed by the primary photochemical process $CH_3CHN_2 + h\nu \rightarrow CH_3CH + N_2$. A.

535.347 : 535.51

199. Dichroic coloured polarizers. H. SCHERER. *Z. Naturforsch.*, **6a**, 440–5 (*Aug.*, 1951) *In German.*

Results of quantitative measurements on stretched and coloured polyvinyl alcohol films in the wavelength range 250 to 500 mμ are presented. The dichroism can be explained if the absorption by the colouring matter is considered. Graphs and a photograph show that it is possible to construct a pigment polarizer for ultra-violet light. H. G. JERRARD

535.347 : 536.48

200. The dispersion of the optical absorbing power of soot particles in flames. W. PEPPERHOFF. *Optik*, **8**, 354–66 (*No.* 8, 1951) *In German.*

The optical properties of flames are considered as diffraction by the finely divided carbon particles in the flame. The variation of the absorption with wavelength is calculated from the constitution of the flame by Mie's theory. Using particle sizes obtained by electron microscopy, this theory gives good agreement with experiment. R. W. FISH

535.371

201. The hydrogen flame as a source of electrons. O. NEUNHOEFFER. *Z. phys. Chem.*, **197**, 179–85 (*June*, 1951) *In German.*

Suitable specimens were found to show luminescence when held near the bottom of a hydrogen flame. This is believed to be due to the recombination of the positive and negative carriers of electricity on the specimen (see Abstr. following). P. T. LANDSBERG

535.371

202. A contribution to the activation mechanism of luminescent materials. O. NEUNHOEFFER. *Z. phys. Chem.*, **197**, 186–8 (*June*, 1951) *In German.*

It has been inferred from experiments (see preceding Abstr.) that luminescent materials may be activated by the presence of free and almost unaccelerated positive and negative carriers of electricity (see also Abstr. following). P. T. LANDSBERG

535.371

203. Remarks about the papers "A contribution to the activation mechanism of luminescent materials" and "The hydrogen flame as a source of electrons" by O. Neunhoeffer. K. F. BONHOEFFER. *Z. phys. Chem.*, **197**, 189–90 (*June*, 1951) *In German.*

It is stated that Neunhoeffer's conclusion (see preceding Abstr.) may be regarded as established only if no luminescent effects can be observed in a stream of atomic hydrogen which has been freed of free current carriers by the application of an electric field. P. T. LANDSBERG

535.371

204. Correspondence between light yield and grain size in polycrystalline crystal phosphors. I. BROSER AND W. REICHARDT. Note in *Z. Naturforsch.*, **6a**, 466–7 (*Aug.*, 1951) *In German.*

A quantitative relation is found between light yield and ratio of crystal grain area to grain volume for α- and γ-ray excited ZnS–Cu and CdS–Ag phosphors ground to different grain sizes. For u.v. excitation the light yield of unground phosphors is independent of excitation intensity but for well-ground phosphors is proportional to it. Correspondence with the results

of phosphor destruction by alpha-particles provides a possible explanation of "pressure destruction" of phosphors in terms of the increase in non-radiative transitions from electron traps to the valence levels of the phosphor crystals. G. F. J. GARLICK

535.371

205. The temperature coefficient of scintillation phosphors. W. L. MINARIK AND H. G. DRICKAMER. Note in *Rev. Sci. Instrum.*, **22**, 704–5 (*Sept.*, 1951).

Results, additional to those of other workers, are given for the temperature dependence of scintillations in phosphors over the range −25 to 250°C for anthracene, $CaWO_4$ and NaI–Tl when excited by a 0·1 millicurie Ra source. G. F. J. GARLICK

535.371

206. Scintillations in the diphenylpolyenes and related compounds. W. S. KOSKI AND C. O. THOMAS. *J. Chem. Phys.*, **19**, 1286–90 (*Oct.*, 1951).

Scintillations in two series of structurally related organic compounds were investigated. One series was composed of the symmetrical diphenyl derivatives of ethane, ethylene and acetylene. The other series consisted of the diphenyl polyenes from diphenyl to diphenyl octatetraene. In the first series it was found that the wavelength of the emission spectra ranged from 3 550 to 4 030 Å and the counting efficiency increased with the number of π-electrons in the system. In the second series the emission spectra wavelengths ranged from 3 400 to 6 000 Å and increased as one went up the series, whereas the counting efficiency went through a maximum at diphenyl butadiene. The results were interpreted in terms of the "metallic" model for conjugated compounds. A.

535.371

207. Scintillations from organic crystals: specific fluorescence and relative response to different radiations. J. B. BIRKS. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 874–7 (*Oct.*, 1951).

The scintillation response S of organic crystals depends on the nature and energy E of the incident ionizing particle, of residual range r. The specific fluorescence dS/dr is not in general proportional to the specific energy loss dE/dr. By considering the quenching effect of the molecules damaged by the particle on the "excitons" produced by it, it is shown that $dS/dr = (A\,dE/dr)/(1 + kB\,dE/dr)$. A and kB are constants, which have been evaluated for anthracene from observations of S and E, and the range-energy data. Curves are computed for the relative response S of anthracene to electrons, protons, deuterons and α-particles of E up to 15 MeV, and these are shown to agree closely with the available experimental results. The method used for evaluating the relative response is applicable to ionizing particles of any nature or energy, and also to the other organic scintillation crystals. A.

535.371

208. The determination of the distribution of electron trapping states in phosphors. C. BULL AND D. E. MASON. *J. Opt. Soc. Amer.*, **41**, 718–26 (*Oct.*, 1951).

Experimental evidence is provided for the existence, in certain infrared-sensitive phosphors, of a considerable number of electron traps which do not give rise to thermoluminescence when electrons are released from them by thermal activation. These studies also provide some further information about nonradiative processes occurring during the thermoluminescence and stimulation of phosphors. Possible methods of obtaining the true distribution of the activation energies of electron traps in phosphors are discussed in some detail. A.

535.371 : 539.166

209. Fluoroscopy with gamma rays. C. GARRETT AND A. MORRISON. *Nucleonics*, **9**, 44–51 (*Sept.*, 1951).

Experiments were carried out with a small intense source of Ir^{192} giving 1·89 r/hr at 1 m. The comparatively low Ir^{192} gamma-ray energies 200–600 keV are an advantage in this work. Suitable fluorescent screens were observed to glow when irradiated in a dark room by the source and shadows of metallic objects could be seen. Penetrameter tests indicated that the sensitivity of the method is not very high; 25% variation in the thickness of a flat steel specimen could be detected compared with 2% in a radiograph using the same source. Measurements of the comparative luminance of different types of screen and the variation of luminance with thickness of steel absorbers placed in the beam are described. L. R. SHEPHERD

535.372

210. Low temperature luminescence of inorganic solids. C. C. KLICK. *J. Opt. Soc. Amer.*, **41**, 816–23 (*Nov.*, 1951).

The emission spectra of a representative group of inorganic solid phosphors have been measured at temperatures as low as 4°K. Of the phosphors investigated, only those having "edge" emission show a tendency to exhibit a line spectrum at low temperatures; the ordinary impurity-activated materials show little or no change in emission below 100°K. It is improbable that the breadth of emission is due to the interaction of the luminescent centre with impurities or lattice defects since neither cold work nor variation in concentrations of impurities affects the breadth of emission. Possible explanations of the broad-band, low-temperature emission are the existence of a zero-point vibrational energy of a non-photoconducting luminescent centre in its excited state; and, in the case of photoconducting phosphors, the distortion of exciton and conduction levels near the luminescent centre. A.

535.375.5

211. The Raman spectra of methylbromosilanes. H. MURATA AND S. HAYASHI. Letter in *J. Chem. Phys.*, **19**, 1217–18 (*Sept.*, 1951).

Observed Raman frequencies for methyltribromosilane, dimethyldibromosilane and trimethylbromosilane are in good agreement with values calculated using the method and force constants described by T. Shimonouchi [*J. Chem. Phys.*, **17**, 245, 848 (1949)]. Vibrational assignments are made. W. R. ANGUS

535.375.5

212. Multiple reflection Raman tubes for gases. H. L. WELSH, C. CUMMING AND E. J. STANSBURY. *J. Opt. Soc. Amer.*, **41**, 712–14 (*Oct.*, 1951).

The efficiency of a Raman tube for gases can be

increased by multiple reflections from concave mirrors. With a four-mirror arrangement, the intensity of the scattered light entering the spectrograph is increased by the factor $1/(1 - R)$, where R is the reflectivity of the mirrors. A two-mirror Raman tube is described, which gave a nearly fourfold increase in intensity in the ultraviolet. A.

535.375.54

213. A complementary filter method for Raman research on a crystalline powder. W. Guber and K. H. Riggert. Note in *Z. Naturforsch.*, 6a, 464–6 (*Aug.*, 1951) *In German.*

Results obtained for the Raman spectrum of solid naphthalene using a complementary arrangement of interference filters are in good agreement with recorded data. W. R. ANGUS

535.39

214. The reflexion of light from glass with a transparent homogeneous surface-layer. M. Brdička. *Bull. Int. Acad. Tchèque Sci.*, **48**, 63–70 (1947).

The electromagnetic equations are applied to a beam of light incident upon a thin surface layer on glass. These equations are transformed into a 5th-order algebraic equation which can be solved to give the thickness and refractive index of the layer from practical measurements of the angle of refraction, the elliptical polarization of the reflected beam and the phase difference between the two components. R. W. FISH

535.39

215. The reflexion of light from glass with a natural transparent inhomogeneous surface-layer. M. Brdička. *Bull. Int. Acad. Tchèque Sci.*, **49**, 81–9 (1948).

The reflected beam from a glass-air surface shows elliptical polarization which is believed to be due to the presence of a surface layer. The dielectric constant is assumed to vary within the layer in a regular manner with the distance from its surface. The electromagnetic equations then allow the mean refractive index and thickness of the layer to be determined from the amount of elliptical polarization and the phase differences. Experimental results show good agreement with calculated values. R. W. FISH

535.39

216. An infrared reflectometer. M. S. Oldham. *J. Opt. Soc. Amer.*, **41**, 673–5 (*Oct.*, 1951).

The properties of this reflectometer include the use of essentially parallel radiation and the capability of choosing the angle of incidence at the surface being investigated. The alignment and calibration procedures which were used are presented. A description of component parts such as special mirror mounts and infrared polarizers as well as type and reliability of resultant measurements are included. Sample measurements taken on evaporated Be films of various thicknesses are presented in graphical form. A.

535.39

217. The impedance concept in thin film optics. P. J. Leurgans. *J. Opt. Soc. Amer.*, **41**, 714–17 (*Oct.*, 1951).

The one-to-one correspondence between transmission line theory and the theory of the optical behaviour of thin films is discussed in detail. Advantage is taken of this analogy to apply the methods developed for the solution of transmission line problems to problems involving transparent dielectric films. In particular, the use of Smith Charts as a convenient way of doing these calculations is suggested. The reflection from a triple film is worked out to illustrate the general method, and the conditions for zero reflectivity of a single film are deduced in a simple fashion. A variation of the method is then used to derive a new way of obtaining the optical constants of opaque metal films. This method has been applied to Al films, and the result obtained is in good agreement with that obtained from polarization measurements. A.

535.39, 535.372

218. Absorption, reflection, luminescence emission, and excitation measurements with the Beckman model DU quartz spectrophotometer. C. C. Klick, J. G. Schumacher and R. G. Stokes. *Rev. Sci. Instrum.*, **22**, 776–82 (*Oct.*, 1951).

Modifications of the Beckman model DU spectrophotometer are described which allow it to record continuously emission and excitation spectra of luminescent materials as well as reflection of powders and transmission of solids by point-by-point methods. All the measurements can be made over the wavelength range of 2 200 Å to 7 000 Å. Performance of the instrument is illustrated by measurements made on a thallium-activated potassium chloride phosphor. A.

535.39 : 548.0

219. Gross variations in the physical properties of synthetic crystalline lithium fluoride. S. S. Ballard, L. S. Combes and K. A. McCarthy. *J. Opt. Soc. Amer.*, **41**, 772–5 (*Nov.*, 1951).

Several important physical properties of numerous samples of crystalline lithium fluoride have been measured; and wide variations were encountered, both among samples of air-grown and of vacuum-grown crystals, and between the two types. In general, the vacuum-grown crystals demonstrate the more desirable range of values, particularly with respect to good ultraviolet transmission, freedom from absorption at $2{\cdot}8\ \mu$ in the near infrared, high elastic limit, and small cold flow. However, the variation is so great that average values cannot be relied upon in critical situations where large factors of safety cannot be invoked; in such cases, individual pieces must be measured for the properties of interest. A.

535.412

220. Interference of two beams emerging from a Lummer–Gehrcke plate. E. Charron and N. Segard. *C.R. Acad. Sci.* [*Paris*] **233**, 609–10 (*Sept.* 10, 1951) *In French.*

Conditions are given for the formation of fringes by interference of the two beams emerging at nearly grazing angles from the two opposite faces of a Lummer–Gehreke plate. Each beam is composed of 18 partial beams of nearly the same intensity, although this is not strictly necessary. The fringes are formed at infinity. R. W. FISH

535.417

221. A new, very simple interferometer for the quantitative evaluation of flow images. S. F. ERDMANN. *Appl. Sci. Res.*, **B2**, 149–98 (*No.* 3, 1951) *In German.*

The method is described whereby a Schlieren optical technique is modified to permit alternatively of the formation of interference fringes. The modification introduced is simple. The method is based on phase-contrast. It is applied to the examination of contours of density produced by gas emission from a Laval jet and to supersonic velocity of air around objects. The method permits a combination of interferometric and Schlieren observations rapidly. The procedure is not seriously affected by acoustic or mechanical vibrations. Only preliminary descriptions of applications are given and no detailed analysis. The theory of the method and variants are discussed in detail. S. TOLANSKY

535.417

222. A beam-splitter for non-collimated light. W. WEINSTEIN. *J. Sci. Instrum.*, **28**, 351–2 (*Oct.*, 1951).

An interferometer beam-splitter (semi-reflecting and transmitting element) is described; it is used in non-collimated light, is symmetrical about the dividing plane and introduces no aberration into either beam. A.

535.42 : 535.543

223. Tobacco-mosaic virus crystals and three-dimensional microscopic vision. M. H. F. WILKINS, A. R. STOKES, W. E. SEEDS AND G. OSTER. *Nature* [*Lond.*] **166**, 127–9 (*July* 22, 1950).

Crystalline inclusions in infected tobacco leaves were investigated by means of the polarizing microscope and by u.v. absorption spectroscopy. From the birefringence and refractive index the water content was estimated at 60%. When viewed between crossed Nicols the crystals, though much thicker than the depth of focus of the microscope, showed intense light and dark bands of period varying from 3 000 Å to 6 000 Å, and Bragg reflection could be observed by introducing the Bertrand lens. It is concluded that the crystal has a lamellar structure with the optic axis direction varying periodically in one direction only, and a new theory of image formation for a three-dimensional periodic object is described.

A. R. STOKES

535.421

224. Examination of the resolving power of the diffraction grating. E. HULTHÉN AND U. UHLER. *Ark. Fys.*, **3**, 393–405 (*Paper* 21, 1951).

A photographic and an electric method are described for determining the resolving power of spectroscopic instruments. The first uses a movable plate holder, which can be given known displacements across the beam in the focal plane, the minimum step for a sharp line to remain resolved giving the spectral purity. The electric method uses a double slit with variable separation, in the focal plane before the photo-multiplier. Results for two large concave gratings are discussed. Screening the grating by a system of vertical strips is found to give an increased resolving power. R. W. FISH

535.421 : 531.792

225. The ruling of diffraction gratings at the Mount Wilson Observatory. H. D. BABCOCK AND H. W. BABCOCK. *J. Opt. Soc. Amer.*, **41**, 776–86 (*Nov.*, 1951).

The newer ruling engine of the Mount Wilson Observatory is now producing sizable diffraction gratings of high quality in all respects. Several recent gratings are 7¼ in wide with grooves 5¾ in long, and one is 8 by 5¼ in. Curved-edge ruling diamonds, developed here, have been used in blazing these gratings to specifications for astronomical use. High luminous efficiency is combined with practically complete absence of scattered light, either general or local, in the spectrum. Resolving power of 500 000 is achieved. Rowland ghost intensity is held to about 0·00004 in the first order of 15 000 line per in rulings. Most ruling to date has been at 300, 400, 600 or 900 grooves per mm, but other spacings are available. The rather considerable modifications of the Rowland-type engine are described, with particular reference to the monorail diamond carriage, the coupling of the nut to the grating carriage, the end-thrust bearing of the screw, the use of Nitralloy steel ways, and the spacing mechanism. Blazed plane gratings have almost entirely supplanted prisms in fast stellar spectrographs of both short and long focus. Methods of testing are outlined and a formula proposed for the evaluation of gratings. A.

535.437 : 533.21

Prediction of isothermal compressibilities by light scattering. *See Abstr.* 117

535.51 : 535.14

226. On the Stokes parameters in polarised radiation. D. L. FALKOFF AND J. E. MACDONALD. Letter in *J. Opt. Soc. Amer.*, **41**, 861–2 (*Nov.*, 1951).

Gives a novel way of introducing the Stokes parameters which shows why they appear equally naturally in both the classical and quantum treatments of polarized and partially polarized light.

P. M. DAVIDSON

535.55 : 539.319

227. Mechanical and optical properties of warm-stretched Plexiglass M.33 when tested in tension. H. PEUKERT. *Z. Ver. dtsch. Ing.* [*VDI*] **93**, 831–5 (*Sept.* 11, 1951) *In German.*

Tensile tests were made, using increments of stress, on Plexiglass type M.33, which had been stretched while warm, and showed that the amount of pre-stretching and the stress-optical constant were related. Their magnitudes were independent of the load and the period of loading. The initial amount of pre-stretching while warm appeared critical, for when it was $< 95\%$ the stress/strain diagrams indicated the material to be brittle, while when it exceeded this value, the material appeared tough with pronounced creep characteristics. In the critical region, prolonged loading gave a maximum value of creep.

A. C. WHIFFIN

535.6 : 628.972

228. Psychological aspects of color and illumination. R. M. EVANS. *Illum. Engng* [*N.Y.*] **46**, 176–81 (*April*, 1951).

A general discussion of the possible psychological factors which may have to be considered when study-

ing the subject of colour in illuminating engineering. Each section is followed by a group of questions which, it is suggested, should guide investigations on colour in light and illuminating engineering. There are 61 such questions in all. J. W. T. WALSH

535.625.1 : 612.843.31

229. A psychophysical study of white. III. Adaptation as variant. L. M. HURVICH AND D. JAMESON. *J. Opt. Soc. Amer.*, **41**, 787–801 (*Nov.*, 1951). For Pts I–II, see Abstr. 7789–90 (1951).

Experimental data are presented which provide psychophysical specifications of white in terms of the stimulus variables, colour temperature and luminance, for 10 different adaptive conditions. A single test field size, 11·7°, and a single exposure time, 1 sec, were used. The colour temperatures of the adapting and surround illuminations were: 10 000°K, 7 500°K, 5 500°K, 4 300°K and 2 842°K; and the adapting luminance levels were 5 and 15 mL. The white threshold contours exhibit minima in all cases, and vary systematically with both the colour temperature and luminance of adapting and surround field. These variations are analysed and discussed in terms of chromatic desensitization. Various principles and mechanisms of colour vision are discussed in relation to the psychophysical functions presented in the three papers of this series. It is suggested that the properties exhibited by these functions are most simply interpreted by postulating an independent white mechanism. A.

535.653

230. An experimental color comparator. E. J. KING AND D. S. RODBELL. *J. Opt. Soc. Amer.*, **41**, 830–5 (*Nov.*, 1951).

The design and construction of an experimental subjective colour comparator is discussed. The unit permits binocular viewing of a constant, 2-degree split matching field with a dark surround. During observation of the field, continuous adjustments of the colour of the "standard" side are possible with three controls, each associated with one of the subjective attributes of colour. Data useful in calculating the I.C.I. tristimulus values for the matched sample appear on calibrated dials. Colour samples to be matched by Illuminant "*C*" are inserted in the instrument on small cards. Larger samples—external to the comparator—such as textiles, agricultural products, wall panels, etc., can be evaluated for all types of illumination. In every case, texture in the sample is obscured by the comparator mechanism. Some data is presented to indicate the matching tolerances that can be expected. A.

535.653.85

231. Improved color-difference formula, with applications to the perceptibility and acceptability of fadings. I. H. GODLOVE. *J. Opt. Soc. Amer.*, **41**, 760–72 (*Nov.*, 1951).

A simple formula for computing fadings or other colour differences from Munsell notations has been derived from one simple assumption. Experimental data for the relative visual magnitudes of the Munsell "value" and chroma steps have been incorporated into the formula. It has been tested with several sets of experimental data and found valid even for some large differences. A table of constants facilitates quick application. The formula has been applied to the computation of the colour differences of a great many dyes changing in concentration only, for example, from 2% to 0·5%. This change is known in the textile industry as "on-tone" fading. The user of dyed fabrics dislikes changes of hue more than equally perceptible changes in saturation or lightness, so that acceptability and perceptibility are not identical; hence, the importance of on-tone fading. For the 2–0·5% case, hue change as a function of hue of the stronger dyeing gave a well-defined curve. Maximum hue changes occur at 2*R* and 8*YR*, with zero change between. The total change is lowest for yellows (explaining why dyers find it most difficult to judge their fastnesses) and highest in the blues. Other published formulae yield the reverse of this fact. The question whether fastness is in large part a matter of perceptibility of changes was examined. The graph of perceptibility and of average light-fastness ratings, both as a function of hue, show little resemblance, indicating that the fastness ratings are not primarily due to mere concentration change. A.

535.8

232. Notes on the multiple source Schlieren system. R. A. BURTON. *J. Opt. Soc. Amer.*, **41**, 858–9 (*Nov.*, 1951).

The effect of diffraction by the negative grid, the problem of the formation of a shadow of the negative grid on the viewing screen, and the manufacture of grids are treated briefly. A brief note on mechanical design is included. Five references. A.

535.81

233. Thin sheet plastic Fresnel lenses of high aperture. O. E. MILLER, J. H. MCLEOD AND W. T. SHERWOOD. *J. Opt. Soc. Amer.*, **41**, 807–15 (*Nov.*, 1951).

Fresnel type lenses of high precision and excellent surface quality have been made in thin sheet plastic materials. The prismatic elements are very fine—about 0·003 in to 0·005 in—and are not visible to the average unaided eye. A high degree of correction for spherical aberration has been achieved. Moulded from high precision moulds, lenses have been made in diameters of 2 to 15 in and focal lengths of 2½ to 22½ in. Relative apertures in excess of *f*/1·0 have been made. These lenses have found many applications as light collecting elements where weight and space are limited. Such applications include uses for large condensers, large field lenses in finders, camera viewing screens and translucent screens for projection. A.

535.81

234. Design and construction of Fresnel optics for photoelectric receivers. E. A. BOETTNER AND N. E. BARNETT. *J. Opt. Soc. Amer.*, **41**, 849–57 (*Nov.*, 1951).

The design and construction of Fresnel-type optics particularly suitable for use with area-type photoelectric receivers are described. Such optics have several advantages over conventional lens and mirror systems; large aperture systems may be constructed cheaply and are light in weight, the radiant energy can be distributed uniformly over the sensitive surface to avoid local saturation, and the optics can be economically custom-made for each application. The design procedure is explained and a method given for

the construction of these Fresnel-type lenses from plastic in a modestly equipped machine shop. The design predictions and experimental performance data are compared for lenses designed for three different applications. A.

535.822.9

235. Phase-contrast microscopy. K. W. KEOHANE. *Sci. Progr.*, **39**, 459–70 (*July*, 1951).

Explains the principle and its application, pointing out advantages and limitations.

535.89 : 537.52 : 545.82

236. Gas transport electrodes. L. E. OWEN. *J. Opt. Soc. Amer.*, **41**, 709–11 (*Oct.*, 1951).

The use of a hollow electrode form with the employment of a gas stream to introduce a sample into a spectral excitation column is discussed. Three uses are proposed: the direct introduction into the excitation gap of contaminated gas samples such as dust-laden air, the direct introduction of special atmospheres into an excitation column to utilize their effects on spectral excitation, and the gas transportation of atomized solutions into an excitation gap. A.

HEAT 536

536.2 : 621.3.012 : 621.317

237. On a Beuken model of the smallest dimensions. K.-H. BROKMEIER. *Elektrotech. Z.* [*ETZ*] **72**, 525–8 (*Sept.* 1, 1951) *In German.*

Non-stationary thermal conduction problems are solved on the lines suggested by Beuken. The theoretical basis of the electric analogue model is given in detail and this is applied briefly to a number of practical problems, covering a wide range, e.g. oven insulation, temperature distribution in the ground, in walls and in motors; heat exchange; hardening procedure; warming up of oven charges, etc. E. H. DOCK

536.23

238. The temperature dependence of the thermal conductivity of air. W. G. KANNULUIK AND E. H. CARMAN. *Aust. J. Sci. Res. A*, **4**, 305–14 (*Sept.*, 1951).

The thermal conductivity of air was determined in absolute measure between −183 and 218°c by the "thick-wire" variant of the "hot-wire" method. The apparatus consisted of a platinum wire 11·6 cm long and 1·5 mm in diameter mounted in a 90% Pt 10% Ir tube of 7 mm internal diameter. The temperature variation of the thermal conductivity can be represented with considerable accuracy by the formula $k_t = 5{\cdot}75\times10^{-5}(1 + 0{\cdot}00317t - 0{\cdot}0000021t^2)$. The present paper suggests a value for the thermal conductivity of air at 0°c from a consideration of the data which have been obtained by various hot-wire methods. A.

536.413

239. Microformer dilatometer. E. J. VANDERMAN. *Rev. Sci. Instrum.*, **22**, 757–60 (*Oct.*, 1951).

The construction, calibration, and use of a dilatometer that is ideally suited for use with radioactive materials is described. Expansion measurements are made electrically with a linear variable transformer. A.

536.423 : 541.123.2.034.6

240. Application to the mixed vapours of two non-miscible liquids of the Raoult–Van't Hoff laws relating to dilute solutions. C. TOURNEUX, C. DEVIN AND L. REBÉQUET. *C.R. Acad. Sci.* [*Paris*] **233**, 520–2 (*Aug.* 13, 1951) *In French.*

The classical reasoning which enabled Van't Hoff to establish Raoult's empirical cryoscopic law, is found to be applicable to the mixed vapours of two compounds A and B, which are non-miscible in the liquid state but which deposit a condensate of A when cooled. At infinite dilution for B, the corresponding hydroscopic law is: $\Delta t_r^\circ = K_r \times C_B/M_B$, with $K_r = R\times T_r^{\circ 2}/L_v$; the lowering of the condensation point of A is proportional to the molecular concentration of B in the mixed vapour; T° and L_v are respectively the absolute temperature of condensation and the heat of vaporization of A (at T_r°) under atmospheric pressure. Experimental details for the verification of the law are given when A is water, and B is either nitrobenzene, or acetophenone, or tetralin.

H. H. HODGSON

536.423.15

241. Vapor pressures below 1 mm Hg of several aromatic compounds. E. R. HOPKE AND G. W. SEARS. *J. Chem. Phys.*, **19**, 1345–51 (*Nov.*, 1951).

Vapour pressures of the three isomeric picolines and *p*-di-tert-butylbenzene were determined over a pressure region of approximately 5–250 microns Hg using a Rodebush manometer and an effusion manometer for each compound. The experimental results of the two methods show good agreement. A comparison of the two manometers is made and the merits of each method are discussed. A.

536.46 : 536.521

242. Errata: A two-path method for measuring flame temperatures and concentrations in low-pressure combustion flames. S. S. PENNER. Letter in *J. Chem. Phys.*, **19**, 1434 (*Nov.*, 1951). See Abstr. 4340 (1951).

536.46 : 537.566

243. On the ionization and the luminescence of flames. P. GOERCKE, E. SAENGER AND I. BREDT. *Ann. Télécommun.*, **6**, 250–60 (*Aug.–Sept.*, 1951) *In French.*

The reflection of centimetric e.m. waves by the effluent gases from a liquid-fuel rocket is abnormally high, corresponding to an electron-density of 10^{11} to 10^{14}/cm^3; the value predicted by Saha's equation using the known efflux temp. is 0·08/cm^3. A consideration of the reflection of e.m. waves by an ionized medium shows that although some lack of precision in estimating electron-densities may be expected (due to collision and recombination) this factor is not likely to be very important. It is suggested that the discrepancy may be explained by the fact that equilibrium is not attained in the ionizational degrees of freedom; the ionization-level is that set up during the first 10^3 collisions, when nearly all the energy liberated by the chemical reaction is concentrated in the translational degrees of freedom, giving, for a typical liquid-fuel rocket, an apparent temp. in excess of 28 000°K. At such a temp. ionization would be at approx. the observed level. Atomic excitation would

lso become an important source of radiation, mainly n the u.v., but as the gas-stream is opaque to u.v. adiation, it would be confined to the reaction zone; his intense radiation may contribute the major part f the energy needed to preheat and evaporate the uel and oxidant after their injection into the combus- ion chamber. A. SCHOFIELD

536.48

244. Thermodynamic properties of a non-ideal He^3–He^4 solution model. J. C. MORROW. *Phys. Rev.*, **84**, 502–5 (*Nov.* 1, 1951).

Deviations from ideality for He^3–He^4 solutions are calculated on the basis of a simple real solution model. Expressions for equilibrium total pressure are derived for situations with and without superfluid He^4. Effects of non-ideality on previously reported calculations of lambda-point dependence on He^3 concentration are examined, and an equation representing the lamba-points of concentrated as well as dilute He^3 solutions is given. The results are used in the comparison of various bases for treatment of the lambda-point shift. Assumption that the partial molal enthalpy of superfluid vanishes gives more satisfactory results than assumption of zero partial molal entropy of superfluid. A.

536.48

245. On the thermomechanical effect in adsorbed layers of helium II. L. MEYER AND E. LONG. *Phys. Rev.*, **84**, 551–2 (*Nov.* 1, 1951).

An expression is derived for the thermomechanical effect in adsorbed films, using the methods of quasi-thermodynamics. The results are discussed in comparison with the fountain effect in bulk liquid helium II, and with the existing qualitative measurements on adsorbed helium II films. A.

536.48

246. The rate of transfer of the Rollin–Simon film. G. J. VAN DEN BERG AND W. J. DE HAAS. Letter in *Physica*, **17**, 797–8 (*Aug.*, 1951).

Confirms Abstr. 932 (1950). Somewhat slower rates on a solid H_2 surface. H. LONDON

536.48

247. Effective mass of He^3 and the speed of second sound in solutions of He^3 in He^4. I. M. KHALATNIKOV. *Dokl. Akad. Nauk, SSSR*, **79**, 57–9 (*No.* 1, 1951) *In Russian.*

The experimental results of Lynton and Fairbank [Abstr. 265 (1951)] show that between 1·25 and 1·70°K the effective mass of He^3 in He^4 is independent of temperature and equal to 8·5 proton masses. R. B. DINGLE

536.48

248. Sound of large amplitude in He II. I. M. KHALATNIKOV. *Dokl. Akad. Nauk, SSSR*, **79**, 237–40 (*No.* 2, 1951) *In Russian.*

Criticizes Temperley's theory [Abstr. 2633 (1951)] of shock waves of second sound in He II, and presents a theory based on Landau's equations. The velocity of a shock is found to be $c_{20} + \frac{1}{2}\alpha_2(v_{n1} + v_{n2})$, where $c_{20}^2 = TS^2\rho_s/C\rho_n$, $\alpha_2 = (TS/C)(\partial/\partial T)\ln(c_{20}^3C/T)$, and v_{n1} and v_{n2} are the velocities of the normal fluid on either side of the shock. R. B. DINGLE

536.483

249. Experiments on the production of very low temperatures by two-stage demagnetization. J. DARBY, J. HATTON, B. V. ROLLIN, E. F. W. SEYMOUR AND H. B. SILSBEE. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 861–7 (*Oct.*, 1951).

A two-stage demagnetization apparatus employing a superconducting wire as the thermal switch between the stages is described. Temperatures in the region of 0·003°K have been obtained using a magnetic field of only 4 200 gauss. The problem of thermal insulation was investigated and the residual heat inflow after demagnetization was reduced to one erg/min. The possibility of employing a superconducting switch in cyclical magnetic cooling systems and in nuclear demagnetization is discussed. A.

536.483

250. Counter-current exchanger for liquefying hydrogen or helium. R. SPOENDLIN. *J. Rech. Cent. Nat. Rech. Sci.*, **3**, 311–18 (*No.* 15, 1951) *In French.*

The construction of a heat exchanger for a Joule–Thomson helium liquefier is described, where the exhaust gas flows perpendicular to tubes carrying the entering gas. Measured temperature differences and pressure losses are plotted against helium flow for a cold-end temperature of 77°K. W. H. DENTON

536.5.081

251. On a definition of temperature and the laws of expansion. J. M. T. VIDAL. *C.R. Acad. Sci.* [*Paris*] **233**, 285–7 (*July* 23, 1951) *In French.*

See *C.R. Acad. Sci.* [*Paris*] **232**, 2397 (*June* 25, 1951) and Abstr. 8687 (1951). An abstract temperature which coincides with a generalized Möbius lattice is defined. For two bodies which are always at the same temperature it is shown that $y/y_0 = [A(x/x_0) + B]/[C(x/x_0) + 1]$ with $A + B = C + 1$, where x and y are points in the bodies, thus giving the expansion law for isotropic bodies. Results given for the expansion of galena and pyrite obtained with a Chevenard dilatometer confirm the law. S. WEINTROUB

536.5.081

252. Thermometric scales and expansion coefficients. J. M. T. VIDAL. *C.R. Acad. Sci.* [*Paris*] **233**, 469–71 (*Aug.* 6, 1951) *In French.*

See preceding Abstract. The scales of two thermometers, which depend on the expansion of different substances, are shown to form a projective series and the law of expansion relative to a thermometer is deduced. Some experimental data quoted from the literature is given in support of the results. S. WEINTROUB

536.52

253. A photographic pyrometer. D. W. MALE. *Rev. Sci. Instrum.*, **22**, 769–72 (*Oct.*, 1951).

A photographic pyrometer is described that indicates apparent surface temperatures by photographing hot surfaces and correlating the variable density of the photographic negative with the apparent surface temperature. The need for critically controlled photographic and development technique is eliminated by incorporating into every photograph the images of standard targets whose apparent surface temperatures are independently determined with an optical pyro-

meter. The apparent temperatures of all areas of the photographed region can be determined simultaneously and instantaneously. A.

536.521

254. Measurement of brightness temperatures, of monochromatic emission factors and of the true temperatures of luminous flames by photographic photometry. J. GALEY. *C.R. Acad. Sci.* [*Paris*] **233**, 575–7 (*Sept.* 5, 1951) *In French.*

The flame and a small brighter black body at a known temp. viewed through the flame are photographed through a monochromatic filter on negative panchromatic ciné-film. The film is calibrated by a separate series of exposures on black bodies at known temps.; from successive frames of the calibration film the accuracy of the method can be estimated. The monochromatic emission factor E is given by $E = 1 - (b_2 - b_3)/b_1$ where b_1 is the brightness of the calibration source, b_2 that of the source viewed through the flame and b_3 that of the flame. Using a recording microdensitometer image densities are measured to an accuracy better than 0·01, corresponding to less than 3°c in temp. Variations in film sensitivity and development, and in time of exposure of individual frames of the ciné-film give rise to an additional error of ± 3°c. A. SCHOFIELD

536.532

255. Ambient temperature independent thermopiles for radiation pyrometry. W. G. FASTIE. *J. Opt. Soc. Amer.*, **41**, 823–9 (*Nov.*, 1951).

Most thermopiles show a decrease in sensitivity when ambient temperature increases. By experimental study of the temperature dependence of the various factors which affect the sensitivity (radiation loss, gaseous conduction and convection loss, and losses through the solid supports) it has been determined that a major contributor to the effect at atmospheric pressure is the temperature coefficient of thermal conductivity of the thermocouple wires. Several ambient temperature independent thermopiles operating at atmospheric pressure have been made either by adjusting the size of the thermocouple wires or by addition of other solid conducting supports between the receiver and the cold junctions. A mathematical analysis of the thermal system of a thermopile has led to a simplified formula for determining the proper materials and dimensions required to obtain ambient temperature independence. As a direct result of the analysis it can be stated that any thermopile, operated at atmospheric pressure, can be made ambient temperature independent by the proper choice of a thermal shunt between the receiver and the cold junctions. Limitations of the analysis are discussed. Experimental confirmation of the method is presented. A.

536.581.3

256. Cryostatic apparatus for the study of absorption and the Raman effect. J. MAYENCE. *J. Phys. Radium*, **12**, 744–50 (*July–Aug.–Sept.*, 1951) *In French.*

Describes (1) a cryostat for Raman effect; (2) a cryostat for absorption in u.v. and near i.r.; (3) an entirely metallic cryostat for absorption, Raman effect and photochemistry; (4) a thermostat operated by expansion of H_2 gas. R. B. DINGLE

536.627 : 612.1

257. Physical basis of internal calorimetry. W. CHESTER AND J. GRAYSON. Letter in *Nature* [*Lond.*] **168**, 521 (*Sept.* 22, 1951).

Results of tests of the instrument devised by latter author [*J. Physiol.*, **114**, 29P (1951)] for the measurement of blood flow in living tissues are briefly reported. The instrument consists of a constantan filament connected to a variable potential, and an attached thermocouple to record the filament temperature. The energy required to maintain thermal equilibrium when the instrument is embedded in the experimental material is recorded electrically. The square of the heating current, I^2, was determined with a standard instrument in air, chloroform, vaseline, glycerine, water and mercury and heated to 1°c above the ambient temperature. It was found that $I^2/K = 14{\cdot}0\times10^4(\pm 1\%)$ provided the depth of insertion of the instrument or the bulk of the fluid was sufficient. Values of K, the thermal conductivity, were taken from I.C.T. S. WEINTROUB

536.631 : 548.0

258. Measurements of the true specific heats of KCl–KBr mixed crystals in the temperature range 50 . . . 450°c. A. MUSTAJOKI. *Ann. Acad. Sci. Fennicae*, **A1**, 44 *pp.* (*Paper* 98, 1951) *In German.*

Moser's adiabatic method [*Phys. Z.*, **37**, 737 (1936)] is used. The apparatus, which is fully described, is similar to that of Miekk-oja [*Ann. Acad. Sci. Fennicae*, **A1**, 7 (1941)]. The substance under investigation is in the form of a cylindrical briquette and is enclosed in a Ag calorimeter which is electrically heated. The temperature rise is measured with a Ag-constantan thermocouple. As a preliminary test of the apparatus c_p for Ag for 50–500°c was measured and the results are given in tabular form, represented by $c_p = 0{\cdot}05586 + 1{\cdot}070\times10^{-5}t + 2{\cdot}25\times10^{-9}t^2 \pm 7{\cdot}0\times10^{-5}$ in cal g^{-1} deg^{-1} c, and compared graphically with values obtained by previous investigators. The results for KCl, KBr and for mixed crystals of KCl–KBr with 25, 50 and 75 mol % KCl are shown similarly. For KCl, slowly cooled crystals, $c_p = 0{\cdot}1632 + 6{\cdot}67\times10^{-5}t - 4{\cdot}72\times10^{-8}t^2 \pm 0{\cdot}0007$ and, quenched crystals, $c_p = 0{\cdot}1631 + 6{\cdot}93\times10^{-5}t - 5{\cdot}10\times10^{-8}t^2 \pm 0{\cdot}0007$. For KBr the values were $c_p = 0{\cdot}1045 + 2{\cdot}75\times10^{-5}t - 0{\cdot}42\times10^{-8}t^2 \pm 0{\cdot}0006$ and $c_p = 0{\cdot}1047 + 2{\cdot}58\times10^{-5}t - 0{\cdot}20\times10^{-8}t^2 \pm 0{\cdot}0006$ respectively. For the mixed crystals c_p rises approx. linearly with temp. and is practically independent of the previous heat treatment of the crystals. The measured and calculated (in accordance with the Kopp–Neumann law) specific heats of the mixed crystals differ by less than 0·6%, the former being systematically the greater. S. WEINTROUB

536.631 : 548.7

Specific heat of calcite. *See Abstr.* 641

536.662

259. A new precision calorimeter for the determination of heats of combustion. A. MAGNUS AND F. BECKER. *Z. phys. Chem.*, **196**, 378–96 (*Feb.*, 1951) *In German.*

The calorimeter has been described, and its use has been discussed. Tests showed that the mean error for a single measurement is 0·12%. P. T. LANDSBERG

THERMODYNAMICS 536.7/.8

536.7

260. On the thermodynamics of irreversible processes. I. R. HAASE. *Z. Naturforsch.*, **6a**, 420–37 (*Aug.*, 1951) *In German.*

The equations for entropy flow and entropy production, together with the phenomenological formulation of Onsager's reciprocity relations, are set out and discussed in conjunction with those of Meixner and Prigogine for a number of cases. General inequalities for the phenomenological coefficients are formulated. It is shown that in certain systems a portion of the heat current may be split off which relates to the heat transport of the diffusion current. The so-formed "reduced heat current" makes possible a particularly simple formulation of the results of the phenomenological thermodynamic theory. If the thermal conductivities λ (for homogeneous mixing) and χ (for stationary states) are defined as reduced heat transfer the relations, $\lambda > 0$, $\chi > 0$, $\lambda - \chi = 1/T(\Sigma B_i Q_i) > 0$ are valid, where B_i is the phenomenological coefficient for the superimposed process (i.e. thermo-osmosis, thermo-diffusion, etc.) and Q_i is the transport heat, which may itself be expressed in terms of B_i and the phenomenological coefficients for the isothermal mass transport between different phases or isothermal diffusion. F. E. HOARE

536.7

261. The mathematics of elementary thermodynamics. J. S. THOMSEN; K. MENGER. Letters in *Amer. J. Phys.*, **19**, 476–7 (*Nov.*, 1951).

Discussion of Abstr. 4938 (1950).

536.71

262. A reduced equation of state for gases and liquids. S. W. BENSON AND R. A. GOLDING. *J. Chem. Phys.*, **19**, 1413–15 (*Nov.*, 1951).

An empirical, reduced equation of state is presented which holds with reasonable accuracy for both liquids and gases. Liquid densities of non-associated substances are predicted to within 4%, vapour pressures to within 25%, heats of vaporization to within 10% and gas isotherms reproduced to within 10%. The values predicted for the coefficients of thermal expansion and compressibility are not better than 30%. With the exception of the latter, which are incapable of good representation by any such reduced equation, the equation represents a marked improvement over the van der Waals and Berthelot equations. A.

536.764

263. Second-order transitions and critical points. P. J. PRICE. *J. Chem. Phys.*, **19**, 1281–3 (*Oct.*, 1951).

The thermodynamic formulae, of the Ehrenfest type, applicable to an isolated second-order point on a first-order equilibrium line (e.g. a critical point) are discussed. A.

536.79

264. Some considerations concerning Nernst's theorem. F. E. SIMON. *Z. Naturforsch.*, **6a**, 397–400 (*July*, 1951).

After a brief discussion of the formulation of the 3rd law consideration is given to Nernst's deduction of the law based upon the 2nd law and the condition that the specific heats of all substances tend to zero as $T \to 0$. Objections to the deduction by Bennewitz, Planck and Einstein are outlined and it is suggested that the first two of these are invalid, whilst although that due to Einstein is irrefutable, it is not entirely satisfying. It is shown that for systems in which specific heats disappear as $T \to 0$, but entropy differences do not, would possess a finite thermal expansion at $T = 0$. A particular case is considered where a general law of statistical mechanics is sufficient to lead to vanishing entropy differences with vanishing specific heat. It is asked whether a generalization of this kind of argument to cover all parameters of the system might be made. F. E. HOARE

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

265. A model for the electron. A. MEISSNER. Letter in *Naturwissenschaften*, **38**, 381 (*No.* 16, 1951) *In German.*

Attempts brief qualitative explanations of the emission spectra of atoms, the Curie point and superconductivity in terms of a model in which the free electron has two equal and opposite spins.

P. T. LANDSBERG

537.12 : 539.165

266. On the identity of β-rays with electrons. W. T. DAVIES AND M. A. GRACE. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 846–7 (*Sept.*, 1951).

Examination of the bremsstrahlung from a source of H^3 absorbed on a thin Zr foil, showed that not more than $2 \cdot 5$ in 10^6 of the β-rays are captured in the K shell of Zr. From this it is estimated that not more than a few in 10^6 of the β-rays from H^3 can be other than electrons at $\sim 10^{-14}$ sec, after disintegration.

J. HUGHES

537.122 : 539.153.4

267. Short range interaction of electrons and fine structure of positronium. M. DEUTSCH AND E. DULIT. Letter in *Phys. Rev.*, **84**, 601 (*Nov.* 1, 1951).

The $^3S_1 - {}^1S_0$ separation was found to be $9 \cdot 4 \times 10^{-4}$ eV $\pm$ 15% by observing the quenching in a magnetic field of the ortho-state which is unstable against annihilation. This agrees with the theoretical value [e.g. Abstr. 1504, 3320 (1950)], about half of which is due to the short-range exchange term.

W. J. SWIATECKI

537.13 : 530.145

Fredholm structures in positron theory. *See Abstr.* 81

ELECTROSTATICS . DIELECTRICS 537.2

537.226 : 621.315.61

268. Digest of the literature on dielectrics. Vol. XIV —1950. Edited by R. G. Breckinridge and H. Thurnauer. *Publ. Nat. Res. Coun., Nat. Acad. Sci.* [*Wash.*] *No.* 202 (*Sept.* 15, 1951) 230 *pp.*

This annual volume is prepared by the Committee on Digest of Literature, of the Conference on Electrical Insulation. *Trends in research and development in dielectrics*—1950 (H. Thurnauer) 3 pp. *General and theoretical research in dielectrics* (J. D. Hoffman) 25 pp., 127 refs. *Instrumentation and measurements* (R. D. Field) 10 pp., 94 refs. *The breakdown of dielectrics* (J. Burnham) 11 pp., 47 refs. *Semiconductors* (A. E. Middleton and K. E. Cochran) 38 pp., 275 refs. *Barium titanate and related subjects* (S. Roberts) 9 pp., 45 refs. *Digest of literature on dielectric heating* (F. W. Boggs) 5 pp., 24 refs. *Ceramic insulation* (M. D. Beals) 10 pp., 66 refs. *Insulating liquids* (J. E. Gibbons and W. C. Witham) 17 pp., 104 refs. *Insulating paper* (H. A. Birdsall) 6 pp., 31 refs. *Synthetic plastic insulation* (T. Hazen) 96 pp., 573 refs. *Developments in rubber insulations*—1950 (J. T. Blake and O. S. Pratt) 5 pp., 13 refs.

537.226.2

269. A new method for measuring the dielectric constant and the dielectric loss of liquids in the u.h.f. region. T. Ichikawa, H. Yamamura and H. Negita. *J. Sci. Hiroshima Univ. A*, **15**, 73–7 (*March*, 1951).

A long coaxial resonator, partly filled with liquid, is made to resonate at different lengths, by varying the respective heights of the liquid and air columns by means of tuning plungers. The refractive index, N, is calculated from the ratio of wavelength in air to wavelength in liquid so determined. The loss tangent, $\tan\delta$, is calculated from the ratio of currents at the air-liquid interface, for adjacent resonances of the liquid column, and from this and N, the dielectric constant ε is determined. Values of N, $\tan\delta$ and ε are given for distilled water in the 15-cm region at temperatures ranging from 1–50°C. G. D. SIMS

537.226.2

270. Dielectric properties of a sample of deuterium chloride containing an impurity. C. S. E. Phillips. Letter in *Nature* [*Lond.*] **168**, 518–19 (*Sept.* 22, 1951).

An anomalous 1st-order transition observed in ε' at −140°C is correlated with impurity concentration.

D. H. WHIFFEN

537.226.2

271. Dielectric constant of benzene at 25°C by the Wyman method. A. S. Brown, P. M. Levin and E. W. Abrahamson. *J. Chem. Phys.*, **19**, 1226–9 (*Oct.*, 1951).

Apparatus and techniques are described for obtaining reliable absolute dielectric constants by the Wyman resonance cell method. Calcium hydride has been shown to be a drying agent for benzene far more satisfactory than sodium wire, reducing drying time from the six-month period demonstrated in the literature to an interval approximating one day. At 25°C the values for benzene's dielectric constant were $2{\cdot}2747 \pm 0{\cdot}0003$, but the higher limit is presently preferred. These results fall within the range of the best recent values obtained in other laboratories. The reasons for the discrepancies appear explicable in view of the findings of this investigation. A.

537.226.2

272. Errata: The dielectric constant of water and the saturation effect. Letter in *J. Chem. Phys.*, **19**, 1327–8 (*Oct.*, 1951). See Abstr. 4366 (1951).

537.226.2

273. Dielectric properties of lead zirconate. G. Shirane, E. Sawaguchi and Y. Takagi. *Phys. Rev.*, **84**, 476–81 (*Nov.* 1, 1951).

In order to distinguish whether it is really a ferroelectric or not, the dielectric response of $PbZrO_3$ ceramic to biasing d.c. field has been examined. In contrast to ordinary ferroelectrics, an effect is scarcely detected below the Curie point of 233°C even up to a field strength of 20 kV/cm, except for a slight increase of permittivity at the vicinity of the transition point. In addition, the Curie temperature decreases with increasing biasing field attaining the value $\Delta T_c = -1{\cdot}7$°C for 20 kV/cm. The hysteresis loops of this ceramic have been studied. So long as the amplitude of the applied a.c. field is less than a critical field of about 23 kV/cm, the D–E curves are almost always linear, except that a slight upward curvature becomes perceptible just at the temperature range wherein permittivity increases, and never show any hysteresis characteristics even just below the Curie point. But if the amplitude of the applied field is greater than this threshold value, anomalous hysteresis loops of very impressive form are observed in a narrow temperature range just below the Curie point. These experimental facts all seem to suggest that $PbZrO_3$ may be, not a ferroelectric, but an antiferroelectric. A preliminary pyroelectric test also seems to show that no net polarization grows spontaneously when the sample is cooled through its Curie point. A.

537.226.2 : 541.57

274. The dielectric properties of a series of *dl*-*n*-eicosanols. R. J. Meakins and H. K. Welsh. *Aust. J. Sci. Res. A*, **4**, 359–64 (*Sept.*, 1951).

Initial investigations of the dielectric properties of normal long-chain secondary alcohols were made with the symmetrical compounds because of their ready availability [Abstr. 8722 (1951)]. The properties of long-chain polar compounds are known to vary considerably, however, with the position of the polar group in the carbon chain and it therefore seemed desirable to make dielectric measurements with some unsymmetrical alcohols. The paper describes such an investigation of a series of *dl*-*n*-eicosanols having the hydroxyl groups in the 2-, 4-, 6-, 8- and 10-positions, respectively. The results for the melted forms show that slight asymmetry, as in the 10-compound, has little effect on the dielectric properties, but with the more unsymmetrical 4-, 6- and 8-compounds a considerable enhancement of the dielectric absorption is observed. This is accompanied by increased dispersion of the dielectric constant which, for the 8-compound, reaches a low-frequency value of 15. Both ε'' and ε' decrease during storage at room temperature. Anomalous results are obtained with *dl*-*n*-eicosan-2-ol, probably due to the molecules in

the crystal lattice being alternately reversed, end-to-end. As with the symmetrical secondary alcohols, the recrystallized forms give comparatively little dielectric absorption. A.

537.226.2 : 541.57

275. The dielectric properties of crystalline long-chain *n*-primary alcohols at low frequencies. R. J. MEAKINS AND J. W. MULLEY. *Aust. J. Sci. Res. A*, **4**, 365–71 (*Sept.*, 1951).

See preceding Abstract. In a previous paper it was reported that certain crystalline forms of long-chain secondary alcohols show abnormally large dielectric absorption and dispersion of the dielectric constant at audio and radio frequencies. The present paper describes an extension of the investigation to *n*-primary alcohols and discusses the results in terms of the previously suggested theory of dielectric absorption due to the presence of hydrogen-bonded chains of hydroxyl groups. The most significant feature of the results is that the absorption is larger and occurs at much lower frequencies than for the secondary alcohols. This is considered to be due to the end-to-end arrangement of the molecules in *n*-primary alcohol crystals, which gives double layers of hydroxyl groups and enables the formation of more extensive hydrogen-bond chains. The dielectric constants at the lowest frequencies are almost as large as those previously reported by Hoffmann and Smyth for the "waxy" forms of *n*-primary alcohols. Further aspects described are the changes in dielectric properties during storage, the differences between the melted and recrystallized forms, and the effect of dispersing the molecules in an inert solid solvent. In each of these aspects the observed behaviour is similar to that previously reported for the secondary alcohols. A.

537.226.2 : 548.7

Local fields in ionic crystals. *See Abstr.* 642

537.226.2 : 548.7

Ferroelectricity *versus* antiferroelectricity in barium titanate. *See Abstr.* 643

537.226.2 : 621.315.612.4

276. Properties of beryllium-barium titanate dielectrics. E. N. BUNTING, G. R. SHELTON, A. S. CREAMER AND B. JAFFE. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 15–24 (*July*, 1951).

Dielectrics having compositions in the system $BeO–BaTiO_3–TiO_2$ were matured at 1 240° to 1 525°C. Data are given for the compositions, heat-treatments, absorption and shrinkage. At 25°C the dielectric constant (K) and the reciprocal of the power factor (Q) were determined at frequencies of 50, 130, 1 000 and 20 000 kc/s and at 3 000 Mc/s when K is not greater than 50. At 1 Mc/s K was determined at temperatures between −60° and +85°C and at 130 kc/s, K and Q were determined at temperatures between 25° and 200°C. The linear thermal expansion was measured over the temperature range 25° to 700°C. It varied from 0·58 to 0·77%. The electrical resistivities of a few specimens were measured at 200°C, using a d.c. potential constantly applied for several days. In some cases the resistivity decreased by a factor of 10^5 over a few days. For specimens of some compositions, K and Q changed with time. A.

537.226.3

277. Contribution to the anomalous dispersion and absorption in solids. F. X. EDER. *Z. phys. Chem.*, **196**, 305–16 (*Dec.*, 1950) *In German.*

The dielectric properties (dielectric constant and loss factor for various temperatures) of iso-amyl alcohol, ethylenechlorohydrin and ethylenechloride have been determined. The results have been interpreted, using the theory by Holzmüller [*Phys. Z.*, **41**, 499 (1940)]. P. T. LANDSBERG

537.226.3

278. Dispersion of the dielectric constant according to the Onsager model. M. MANDEL. Letter in *Physica*, **17**, 799–800 (*Aug.*, 1951) *In French.*

537.226.8

279. On a general law concerning the variation of the dielectric constant of a solvent as a function of temperature. TALAT-ERBEN. *Bull. Soc. Chim. France*, **18**, 515–17 (*July–Aug.*, 1951) *In French.*

The law $\log(DT) = a + bT + cT^2$ where D is the dielectric constant and T the absolute temperature is suggested for all solvents. D. H. WHIFFEN

537.226.8

280. Low frequency dispersion in Ni- and Co-ferrites. K. KAMIYOSHI. Letter in *Phys. Rev.*, **84**, 374–5 (*Oct.* 15, 1951).

Describes measurements of the electric low-frequency dispersion for frequencies between 1 and 30 kc/s. The values of the activation energies deduced are identical with those obtained from conductivity measurements. E. P. WOHLFARTH

537.228.4

281. Contribution to the study of the Kerr effect exhibited by dilute solutions of rigid macromolecules. H. BENOIT. *Ann. Phys.* [*Paris*] **6**, 591–609 (*July–Aug.*, 1951) *In French.*

Part I gives theoretical calculations of the magnitude of the Kerr effect in solutions of rigid macromolecules, assuming the latter to be ellipsoidal, and for applied fields in the form of rectangular pulses. Part II describes experiments and results for solutions of three different molecular systems, tobacco mosaic virus, thymonucleic acid and vanadium pentoxide threads. Neither of the first two solutes possesses a permanent dipole moment and it is possible to determine from the results the degree of polydispersion in solution. Vanadium pentoxide shows anomalous behaviour probably due to rapid flocculation of the suspension. G. F. J. GARLICK

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.1

282. Electron mobilities in liquid argon. M. S. MALKIN AND H. L. SCHULTZ. Letter in *Phys. Rev.*, **83**, 1051 (*Sept.* 1, 1951).

Measured by observation of conductivity pulses due to ionization by α-particles of ThC and ThC′. The collision cross-sections for electrons of 10 V mean energy is ~ 100× smaller than for gas. R. B. DINGLE

537.311.3, 538.22

283. Electrical conductivity and magnetic susceptibility of ovalene. H. Akamatu, H. Inokuchi and T. Handa. Letter in *Nature* [*Lond.*] **168**, 520–1 (*Sept.* 22, 1951).

From a powder specimen the measurements were $\sigma(15°c) = 4{\cdot}4\times10^{-16}\,\text{ohm}^{-1}\,\text{cm}^{-1}$, and magnetic anisotropy $\Delta K = -615{\cdot}9\times10^{-6}$. J. JACOBS

537.311.32

284. On the electrical conductivity of zinc oxide in the presence of impurity oxides. K. Hauffe and A. L. Vierk. *Z. phys. Chem.*, **196**, 160–80 (*Sept.*, 1950) *In German.*

The temperature dependence of the electrical conductivity has been studied for the following systems: $ZnO + Cr_2O_3$, $ZnO + Al_2O_3$, $ZnO + Li_2O$, $ZnO + Na_2O$, $ZnO + MgO$. The results suggest that the conductivity of an excess conductor is increased by the addition of cations of greater valency, and decreased by cations of lower valency and that this relationship is reversed for deficit conductors. This is discussed quantitatively. P. T. LANDSBERG

537.311.32

285. On the dependence of the electrical conductivity of some mixed oxides on oxygen pressure. K. Hauffe and J. Block. *Z. phys. Chem.*, **196**, 438–46 (*Feb.*, 1951) *In German.*

ZnO and NiO have been investigated, and the effect of adding oxides of metals of both higher and lower valencies has been studied. P. T. LANDSBERG

537.311.32 : 548.7

286. The dependence of the ion conduction in anomalous mixed crystals of the silver halogens on pressure. W. Jost and S. Mennenöh. *Z. phys. Chem.*, **196**, 188–95 (*Sept.*, 1950) *In German.*

The pressure coefficient of the conductivity was found to decrease for AgCl as $PbCl_2$ was added, but it showed a more complicated behaviour for AgBr as $PbBr_2$ was added. This is discussed.

P. T. LANDSBERG

537.311.33

287. Electrical properties of selenium. II. Microcrystalline selenium. H. W. Henkels. *J. Appl. Phys.*, **22**, 1265–78 (*Oct.*, 1951).

For Pt I, see Abstr. 6975 (1951). The electrical properties of Se have been studied in their dependence on history of preparation, i.e. as functions of temperature of initial liquid Se, quench procedure, nucleation procedure, temperature of crystallization and time of crystallization. The electrical properties of melt single crystals and the microcrystalline matrix of these crystals have been compared. The influence of nonmetals S, O_2, I_2, in small quantities on the electrical properties has been determined. Carrier densities and effective mobilities as functions of temperature of measurement have been estimated from data on thermoelectric powers and resistivities. The order of the carrier densities have been checked by measurements of the voltage dependence of capacity of completely vacuum prepared rectifiers. The frequency dependence of resistivity has been determined to gain insight into the nature of the effective mobilities. A.

537.311.33 : 539.11

288. Effect of the change in lattice parameter on the width of the forbidden energy zone according to Kronig and Penney's one-dimensional lattice model. E. Billig. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 878–80 (*Oct.*, 1951).

The effect of changing the lattice parameter in Kronig and Penney's linear lattice model is investigated theoretically. Möglich and Rompe have predicted a decrease in the width of the forbidden energy zone as the lattice parameter is increased. It is shown that this is true only if the width of the potential troughs is increased whilst the thickness of the barriers is maintained constant. However, the opposite effect, i.e. an increase in the width of the forbidden zone, is expected when the potential troughs are kept constant and the width of the barriers is increased instead. In the intermediate case of a uniform expansion of potential hills and troughs, a small net decrease in the width of the forbidden zone is expected. A.

537.311.33

289. Residual resistance in an extremely impure semiconductor. R. W. Wright. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 949–50 (*Oct.*, 1951).

Measurements of conductivity as a function of temperature for highly impure CdO are described and supplement data given previously [Abstr. 5407 (1951)]. These data together with results of projected measurements at lower temperatures should throw light on the problem of the transition from a semiconductor to an impurity metal in such materials.

C. A. HOGARTH

537.311.37

290. A pressure counterbalancing apparatus for the measurement of the electrical conductivity of aqueous solutions above their critical temperatures. J. K. Fogo, C. S. Copeland and S. W. Benson. *Rev. Sci. Instrum.*, **22**, 765–9 (*Oct.*, 1951).

The apparatus described is used in the measurement of the electrical conductivity of vapour phase systems at temperatures to 400°c and pressures to 4 500 lb/in². A small, lightly constructed, platinum-iridium conductivity cell is enclosed in a larger, heated, steel pressure vessel. The pressure developed in the conductivity cell on heating is counterbalanced by admitting N into the pressure vessel. The direction and magnitude of the pressure differential between the vapour in the cell and the surrounding N is indicated by a meter circuit which measures the potential drop of a radio-frequency current across a variable condenser which is operated by an aneroid diaphragm on the cell. Admission and release of N is controlled manually. Measurements of the cell resistance are made by conventional a.c. bridge methods and are not described. A.

537.312.5

291. The behaviour of selenium photocells under short-time illumination. J. Eggert. *Z. phys. Chem.*, **196**, 35–9 (*Sept.*, 1950).

Sudden and intense illumination due to a flash bulb is considered. A ballistic galvanometer was used for the measurement of current pulses and a photographic plate for measurement of the intensity of illumination.

P. T. LANDSBERG

537.312.5

292. Photoconductive cells of cadmium selenide. E. SCHWARZ. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **64**, 821–2 (*Sept.*, 1951).

A CdSe cell of $9{\cdot}8 \times 0{\cdot}185$ mm² sensitive area has been measured and the spectral data of the cell are reported. Results seem to indicate that the author's theory has been established. W. SUMMER

537.312.5

293. Note on the relativistic formula for photoelectric absorption. H. HALL. Letter in *Phys. Rev.*, **84**, 167 (*Oct.* 1, 1951).

Draws attention to a paper by the same author [*Rev. Mod. Phys.*, **8**, 358–97 (*Oct.*, 1936)] which showed that a much-quoted criticism of this formula is unjustified. P. M. DAVIDSON

537.312.5

294. On the photoelectric emission and energy structure of BaO. L. APKER, E. TAFT AND J. DICKEY. *Phys. Rev.*, **84**, 508–11 (*Nov.* 1, 1951).

Spectral distributions of the photoelectric yield and energy distributions of the photoelectrons were obtained for BaO surfaces made in widely different ways. A small and variable yield for $h\nu < 5$ eV was attributed to unidentified imperfections. At the optical absorption edge, there was an effect much like the exciton-induced photoemission in alkali halides. At $h\nu \sim 5$ eV, an abrupt rise in the yield was ascribed to emission from an occupied band of electron states with an upper edge 5 eV below the vacuum level. Energy distributions were consistent with this interpretation. A.

537.312.5 : 535.34

Optical absorption and photoconductivity of amorphous and hexagonal selenium. *See Abstr.* 180

537.312.5 : 535.37

295. Studies on the photovoltaic effect. II. I. LEVIN AND C. E. WHITE. *J. Chem. Phys.*, **19**, 1079–84 (*Sept.*, 1951).

For Pt I, see Abstr. 5839 (1950). Benzaldehyde dissolved in alcohol in concentrations less than $0{\cdot}1\ M$ yields a positive photopotential and in greater concentrations the photopotential is negative. The production of the negative photopotential is attributed to the presence of peroxybenzoic acid. In general, oxygen in the peroxide linkage seems to cause negative photopotentials and oxygen in a carbonyl group yields positive photopotentials. Strong inorganic oxidizing agents produce negative photopotentials. Inorganic reducing agents and salts which are not oxidizing agents yield little or no photopotentials. A polar solvent is necessary for the production of a photopotential. A photopotential-spectrum curve which in general follows the light absorption curve is derived for anthraquinone. High photopotentials can be obtained at wavelengths where light absorption is low if a high intensity light source is used. A.

537.312.5 : 620.179.15 : 621.315.59

296. An economical industrial X-ray detector. R. FRERICHS AND J. E. JACOBS. *Gen. Elect. Rev.*, **54**, 42–5 (*Aug.*, 1951).

Hexagonal CdS has a very high dark resistance which suggests the use of thick crystals. Self-amplification reaches 10^4. The crystals show a dark-red luminescence. The mechanism of photoconductivity and amplification is explained in terms of the band levels. A field strength of 5 000 V/cm will carry 10^4 to 10^5 electrons from cathode to anode for each electron leaving the crystal. The inherent amplification is much increased if the radiation strikes the crystal in a region close to the cathode. The time lag to reach full output is about 5 sec for 95% of the final value for strong radiations and more for weak energies. Applications are described, including the inspection of packaged goods (rate: 600/min) and an arrangement for checking continuity and position of a homogeneous line of material, e.g. the metal core of electric cables. See also Abstr. 297 (1952). W. SUMMER

537.312.5 : 620.179.15 : 621.315.59

297. Electrical conductivity of cadmium sulphide exposed to pulsating X-radiation. J. E. JACOBS. *Elect. Engng* [*N.Y.*] **70**, 667–71 (*Aug.*, 1951).

Cadmium sulphide crystals are used in the high-speed automatic X-ray inspection of homogeneous materials. A self-rectifying copper target X-ray tube (Be-window, 4 mA, peak 14·7 kV) with more than three Ni-filters gives a practically monochromatic beam. CdS crystals retain their characteristics if bombarded with 10^{12} quanta. The normally incident number of quanta is $3{\cdot}10^3$ or of that order. Individual crystals may show a variation in sensitivity to incident X-radiation by a factor of 100. Illumination of the crystal with green light (5 200 Å) greatly increases the a.c. component of the current. Red and blue light have the opposite effect. Superimposed green light also reduces substantially the time necessary to reach stabilized operating conditions. Annealing of the crystals in an O-atmosphere results in the ratio of output current/incident quanta being increased by a factor of 100. Irradiation of a region close to the negative electrode yields max. output. An explanation of the observed phenomena is given. W. SUMMER

537.312.62

298. A note on Fröhlich's theory of superconductivity. K. HUANG. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 867–73 (*Oct.*, 1951).

It is shown that the physical mechanisms underlying the two energy terms E_1 and E_2 in Fröhlich's theory are very different: E_1 is largely the energy change due to a modification of the lattice vibration frequencies caused by the adiabatic deformation of the electrons; E_2 is on the other hand a dynamical term, representing the energy change due to virtual collisions between lattice oscillations and electrons. A proof is given that certain inadmissible consequences of the theory, pointed out recently by Wentzel, derive from the energy term E_1; the superconductive behaviour discussed by Fröhlich arises, however, entirely from the term E_2. Although both terms follow from the same perturbation treatment, the analysis given makes it seem not unlikely that whatever mechanism actually inhibits E_1 will leave the superconductive behaviour deduced from E_2 not substantially affected. A.

537.312.62

299. On the nature of the superconducting state. L. TISZA. Letter in *Phys. Rev.*, **84**, 163 (*Oct.* 1, 1951).

Application of symmetry considerations to the

coupling between electron and phonon gas gives a possible phase transition into a state exhibiting a superstructure as in Abstr. 1847 (1951). H. LONDON

537.312.8 : 536.48

300. Anomalous resistance of noble metals containing paramagnetic ions. A. N. GERRITSEN AND J. KORRINGA. Letter in *Phys. Rev.*, **84**, 604 (*Nov.* 1, 1951).

A preliminary theoretical discussion of experiments [Abstr. 8744 (1951)] on diluted alloys of Mn in Cu, Ag and Au. P. T. LANDSBERG

537.312.9 : 778.3 : 620.172.222

301. The formation of electrically conducting images on film base. D. C. GRESHAM AND E. E. LOENING. *Process Engrav. Mon.*, **58**, 9–13 (1951).

Small electrical resistors for use as strain gauges were made experimentally on film base by a photomechanical process. Sheets of cellulose acetate film base were surface hydrolysed in NaOH solution, treated in stannous chloride solution and silvered in a glass-silvering solution. A hardened glue resist printed from a photographic negative of the filament design was formed on the silvered film in the usual way. The unprotected silver was dissolved away in an alcoholic solution of ferric nitrate and the silver line image was thickened by electroplating with copper. Methods of soldering wires to the ends of such gauges are described.

PHOTOGRAPHIC ABSTRACTS

537.313 : 513.83 : 621.392 : 621.3.011

302. The fundamental theorem of electrical networks. J. L. SYNGE. *Quart. Appl. Math.*, **9**, 113–27 (*July*, 1951).

An exposition, for electrical engineers, of the application of topology to the theory of networks. A mesh and a tree are defined, and various theorems relating to these are deduced. The use of Kron's transformation matrix C is discussed. The element C_{pq} of this matrix has the value $+1$ if the branch p is contained in mesh q and has the same sense, the value -1 if the opposite sense and the value 0 if branch p is not contained in mesh q. The fundamental theorem is this. Given a network, there exists at least one set of basic meshes such that the following statements are true: (1) If a set of mesh currents $\mathbf{i}'$ is arbitrarily assigned, the branch currents given by $\mathbf{i} = \mathbf{C}\mathbf{i}'$ satisfy Kirchhoff's node law at every node; (2) If a set of branch currents $\mathbf{i}$ is assigned, arbitrarily except for the satisfaction of Kirchhoff's node law at every node, there exists a set of mesh currents $\mathbf{i}'$ in the basic meshes such that $\mathbf{i} = \mathbf{C}\mathbf{i}'$. L. S. GODDARD

537.313 : 621.313.2–8 : 621.316.721

303. Wide range, continuously variable high current generator control. J. R. WOLFF AND M. S. FREEDMAN. *Rev. Sci. Instrum.*, **22**, 736–42 (*Oct.*, 1951).

A circuit is described for controlling the output current of a high current (100 A) d.c. generator driving a low impedance (2·5 ohm, 40 mh) load. The circuit features precise continuous control of the load current by a single dial potentiometer over the range from zero to full output, with 0·03% linearity of current *v.* potentiometer setting. A method is presented for reduction of current ripple from the generator in the low impedance load. A.

537.323

304. Thermoelectric power of carbons and graphite. E. E. LOEBNER. Letter in *Phys. Rev.*, **84**, 153 (*Oct.* 1, 1951).

The thermoelectric power of baked carbon rods was found to vary greatly with the temperature to which they had been baked. The theory is discussed. P. M. DAVIDSON

537.363

305. The cataphoresis of spherical fluid droplets in electrolytes. F. BOOTH. *J. Chem. Phys.*, **19**, 1331–6 (*Nov.*, 1951).

A theory of the electrophoresis of spherical fluid droplets in an electrolyte is developed. A general formula is given for the electrophoretic velocity in terms of the applied field, the potential distribution in and near the drops and the dielectric constants and coefficients of viscosity of the liquid and electrolyte. It is assumed that the liquid drop retains its spherical form in cataphoresis and also that relaxation effects in the electrolyte may be neglected. Detailed formulae are worked out for the case of a Debye–Hückel potential in the electrolyte, and the following charge distributions in the fluid sphere: (*a*) no charge within the sphere, the whole charge concentrated on the interface; (*b*) uniform volume distribution of charge; (*c*) ionic double layer potential in the sphere. It is shown that sundry special cases of the theory agree with previous computations and that it is not legitimate to apply theories of the cataphoresis of solid particles to fluid drops. A.

ELECTRIC DISCHARGES 537.52

537.523.3

306. Impulse corona on the surface of water solutions. S. SAKAMOTO. *Mem. Fac. Engng, Hokkaido Univ.*, **8**, 1–13 [*March* (I) 1950].

Describes exptl. work on the properties of corona discharges between a needle point and a water surface, for impulse voltages. Surface figures (like those of Lichtenberg) are formed on the liquid surface and may be photographed. These are described, together with expts. on the ignition of inflammable films spread on the water and on the observation of the emission spectra of the corona discharges. J. D. CRAGGS

537.525

307. Electron density distribution in a high frequency discharge in the presence of plasma resonance. W. P. ALLIS, S. C. BROWN AND E. EVERHART. *Phys. Rev.*, **84**, 519–22 (*Nov.* 1, 1951).

In a h.f. discharge plasma resonance maximizes the electric field, thus producing a high ionization rate in the regions near resonance. The effect of this on the distribution of electrons and of ionization in a parallel plane discharge is calculated and compared with the observation that the light from such a discharge often is a minimum at the centre. A.

537.525.5

308. The effect of oxide impurities upon the initiation of arcs. F. H. NEWMAN. Letter in *Brit. J. Appl. Phys.*, **2**, 303–4 (*Oct.*, 1951).

537.525.8

309. Boundary effects in the striated positive column. R. G. Fowler. Letter in *Phys. Rev.*, **84**, 145 (*Oct.* 1, 1951).

Describes how striations could not be stabilized opposite a side arm in a low pressure hydrogen glow discharge tube and suggests that any theory of striations should take full account of wall effects.

J. D. CRAGGS

X-RAYS 537.531

537.531 : 535.338.1

310. The *K*-spectrum of neon. V. Kunzl and M. Svobodová-Joanelli. *Bull. Int. Acad. Tchèque Sci.*, **47**, 91–7 (1946) *In French.*

The *K*-spectrum of neon is investigated using a bent mica crystal and a specially designed discharge tube operating at 1 800–2 000 V and 100–200 mA. The strongest lines found correspond to those occurring in the *K* series of neighbouring elements that are higher in the Periodic Table but other lines also occur that are not present in the spectra of these elements. The $K_{\alpha_{1,2}}$ wavelength is found to be 14·618 Å. J. THEWLIS

537.531 : 535.43

311. Small-angle X-ray scattering from argon. W. Graham and L. H. Lund. *J. Chem. Phys.*, **19**, 1380–2 (*Nov.*, 1951).

A correlation function as introduced by Debye in the case of light scattering is used to characterize the inhomogeneities in liquid A for those cases showing excessive small-angle X-ray scattering. This method of characterizing the inhomogeneities is compared with the method of characterizing the inhomogeneities as droplets. Curves showing the correlation functions for the various cases are also presented. A.

537.531 : 539.166

312. On the polarization of high energy bremsstrahlung and of high energy pairs. M. M. May. *Phys. Rev.*, **84**, 265–70 (*Oct.* 15, 1951).

The polarization of bremsstrahlung due to electrons with initial energies much larger than $137Z^{-\frac{1}{3}}mc^2$ is calculated under relativistic, small angle approximations. The cross-section for photons polarized normally to the plane containing the initial direction of the electron and the direction of the photon is found to be larger than for photons polarized in that plane. A similar calculation shows that the plane containing one of a pair produced by a polarized photon together with the direction of that photon tends to lie parallel to the plane of polarization rather than normal to it, except for one special case. The effect of the deviation due to multiple scattering of electrons in the target upon the angular dependence of the polarization is considered. A.

537.531 : 548.73 : 778.33

313. Intense gallium X-rays for microradiography and diffraction investigations. A. Taylor. Letter in *Nature* [*Lond.*] **168**, 471–2 (*Sept.* 15, 1951).

A Ga target can be used successfully in a rotating-anode X-ray tube. The $K\alpha$ radiation of Ga may be useful in the microradiography of brasses and for some diffraction investigations. A. E. De Barr

537.531 : 614.898

314. Are X-ray tube demonstrations safe? R. Schlegel and J. C. Lee. *Amer. J. Phys.*, **19**, 470–3 (*Nov.*, 1951).

Measurements of the radiation in the neighbourhood of an unshielded demonstration X-ray tube give intensities ranging from 6 roentgens per min within a few cm of the tube to no appreciable radiation per min a few meters from the tube. The genetic and body effects of radiation are discussed. These effects are such that X-ray demonstrations should be given with greater care than is perhaps now generally exercised. A.

537.531 : 621.386.1

315. OEG-60 beryllium window tube. T. H. Rogers. *Cath. Press*, **8**, 7–9 (*Summer*, 1951).

A comparison of the new OEG-60 X-ray tube with the earlier pattern, AEG-50. Working voltage is increased to 60 kV and the target angle from 20° to 45° to give greater beam spread for therapy.

F. T. FARMER

537.531 : 621.386.1

316. X-ray tubes with Be windows. R. Griffoul. *Vide*, **6**, 995–1006 (*May*, 1951) *In French.*

A survey of l.v. X-ray tubes with Be windows. The general features of X-ray emission are briefly discussed and figures for the absorption in glass, Al and Be given. Several U.S. tubes are illustrated and two French tubes, one for crystallography and the other for therapy. In the latter a W target is placed at the end of a tube 15 cm long and 2 cm in diameter through which the beam is focused by a magnetic lens at the cathode end. The max. rating is 100 kV, 5 mA. A. H. W. Beck (R)

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72

317. Optical properties of axially symmetric magnetic fields of the forms (on the optic axis): $H = H_0/[1 - (z/a)^2]$ and $H = H_0/[(z/a)^2 - 1]$. P. Sturrock. *C. R. Acad. Sci.* [*Paris*] 233, 401–3 (*July* 30, 1951) *In French.*

Glaser's formulae for $H = H_0/[1 + (z/a)^2]$ are transformed to the present cases, the first of which may be applied to the Siegbahn–Slätis β-spectrograph [Abstr. 3185 (1950)] and the second to an electron microscope objective. J. C. E. JENNINGS

537.533.72

318. On an independent electrostatic lens with minimum elliptic astigmatism. E. Regenstreif. Letter in *J. Phys. Radium*, **12**, 760–1 (*July–Aug.–Sept.*, 1951) *In French.*

See Regenstreif [Abstr. 7938 (1951)]. The longitudinal astigmatism $\propto$ the ellipticity, the factor of proportionality depending only on the axially symmetric lens. J. C. E. JENNINGS

537.533.72

319. On certain formulae in electron optics. M. BERNARD. Letter in *J. Phys. Radium*, **12**, 761–2 (*July–Aug.–Sept.*, 1951) *In French.*

An e.s. lens is treated as a system of refracting surfaces, whose curvature is that of the equipotential surfaces; hence integral expressions are obtained for the focal length. J. C. E. JENNINGS

537.533.72, 537.534.72 : 621.385.833

320. Two-directional focusing of charged particles with a sector-shaped uniform magnetic field. W. G. CROSS. *Rev. Sci. Instrum.*, **22**, 717–22 (*Oct.*, 1951).

For a sector-shaped, uniform magnetic field with source and detector outside the field, the non-uniform fringing fields can be employed to give simultaneous focusing of charged particles in two perpendicular directions. Equations for determining the position of the doubly-focused image are developed and graphs are given for some representative arrangements. This double focusing can be combined with the methods recently developed for second-order focusing, to increase further the useful solid angle of a uniform-field mass or momentum analyser. Fringing-field focusing can also be used in concentrating to a point a parallel beam of finite cross-section. A.

537.533.72 : 621.385.833

321. Theory of the three-electrode electrostatic lens. II. E. REGENSTREIF. *Ann. Radioélectricité*, **6**, 114–55 (*April*, 1951) *In French.*

For Pt I, see Abstr. 8770 (1951). The following subjects are discussed here: The lens used as mirror, lenses with slight axial asymmetry, lenses with small holes, the optical parameters of the lens as determined by the position of the inflection in the axial potential, lenses with thick central plates, and the transgaussian state in lens mirror assemblies. All the calculations are given in detail and many of the lens parameters are given in graphical form so that the paper contains design information in a readily available form.

A. H. W. BECK

537.533.72 : 621.385.833

322. Investigation of field distribution in symmetrical electron lens. J. R. SHAH AND L. JACOB. *J. Appl. Phys.*, **22**, 1236–41 (*Oct.*, 1951).

High accuracy of measurement in the electrolytic tank can be achieved by a suitable ratio of impedance as between tank and measuring circuit. With this requirement fulfilled, the axial distribution of the symmetrical lens was explored and found to satisfy a relation $V_z = V_0 + Ae^{-bz(2)}$, where V_0 is the potential of the outers with respect to the middle electrode, z distance from the centre of the lens, while A and b are constants from any one geometry. The effect of varying the separation between the elements was specially investigated. It was found that the maximum value of the gradient between electrodes increases as the separation between them increases, reaches a flat maximum between 0·8 and 0·4 D (D bore diameter) and then decreases with further increase in spacing. This means that a decrease in separation produces a weaker field and an increased focal length. The potential at the saddle point is very sensitive to changes in separation in the region up to about 0·5 D; it was also found to vary linearly with bore up to 3 D. The relaxation method of field plotting was also applied to map the distribution; the results are compared with those given by the tank. A.

537.533.72 : 621.385.833

323. Apertures and diaphragms in magnetic electron microscopy. W. GLASER AND H. ROBL. *Öst. Ingen.-Arch.*, **5**, 36–48 (*No.* 1, 1951) *In German.*

Crossover formation is discussed in generalized axially-symmetrical fields. The aperture of the incident beam in magnetic microscopes is defined as a function of the powers of condenser and objective, and the properties of three special types of diaphragms, "largest diaphragms," "diaphragms of equal aperture" and "contrast diaphragms" are discussed.

A. H. W. BECK

537.533.72

324. Magnetic lens β-spectrometer. P. HUBERT. Letter in *J. Phys. Radium*, **12**, 763–4 (*July–Aug.–Sept.*, 1951) *In French.*

Principal data: iron-free coils i/d 26 cm, o/d 44 cm, length 53 cm, source-counter distance 58 cm, water cooling, 12 kW dissipation, focuses $(H\rho) = 2{\cdot}5 \times 10^4$ gauss cm. With a 2 mm dia. source, measured resolving power = 0·6%, gathering power = 2·5%.

J. C. E. JENNINGS

537.533.72 : 539.165

325. The application of the trochoid method to β-spectra (a focusing process in an inhomogeneous magnetic field). J. LAFOUCRIÈRE. *Ann. Phys.* [*Paris*] **6**, 610–61 (*July–Aug.*, 1951) *In French.*

A full account of the theory, for the median plane, already briefly given in Abstr. 2506 (1950). The present paper also treats spherical aberration and the associated caustic curves and is extended to the case of continuous spectra. J. C. E. JENNINGS

537.533.74

326. On the scattering of slow electrons by hydrogen atoms. T. B. STAVER. *Arch. Math. Naturv.*, **51**, 29–51 (*No.* 1–2, 1951).

The elastic scattering is treated by a variational method, and the effects of polarization and exchange included. The phases and the partial cross-section for $l = 0$ are calculated. The application to the calculation of the continuous absorption coefficient in the solar atmosphere is considered, and the calculation by Chandrasekhar [Abstr. 1414 (1947)] of this quantity discussed. J. HUGHES

537.533.74

327. Multiple scattering of electrons in nuclear emulsions. D. R. CORSON. Letter in *Phys. Rev.*, **84**, 605 (*Nov.* 1, 1951).

Extensive calibration measurements with 40–283 MeV e^+ and e^-, to determine parameters in Fowler's method [Abstr. 3235 (1950)] for deducing the momentum of a fast particle from multiple Coulomb scattering. W. J. SWIATECKI

537.533.75

328. The energy loss of electrons passing through matter. J. J. L. CHEN AND S. D. WARSHAW. *Phys. Rev.*, 84, 335–61 (*Oct.* 15, 1951).

A discussion of the results of a study of the stopping properties for moderately energetic ($\leqslant 1{\cdot}0$ MeV)

electrons is given, with special emphasis placed on the distribution in energy loss for a finite thickness of stopping material. Several theoretical expressions (Bethe–Bloch–Williams, Landau, Blunck–Leisegang) are compared with the data on the value of the most probable loss. A correction for polarization effects (e.g. in Be) can be made if the dependency of the mean excitation potential on velocity is known. The stopping properties of some materials used as, e.g. counter windows, have also been determined. A.

537.533.75

329. Actual path length of electrons in foils. C. N. YANG. Letter in *Phys. Rev.*, **84**, 599 (*Nov.* 1, 1951).

The problem of the statistical distribution with respect to the actual path length for a beam of charged particles is solved in the small-angle approximation in analogy with the usual angular and spatial distribution calculations. W. J. SWIATECKI

537.533.9

330. The radiation from an electron moving in a uniform magnetic field. G. PARZEN. *Phys. Rev.*, **84**, 235–9 (*Oct.* 15, 1951).

The radiation is investigated quantum-mechanically. Reasons are given for expecting deviations from the classical calculations at electron energies of about 100 MeV in the presence of a magnetic field of 10^4 gauss. The quantum-mechanical calculation is carried through and is compared with the classical calculation. Although the deviations are considerable, it is explained why the experiments of Elder, Langmuir and Pollock on the general electric synchrotron would not detect them. A.

537.534

331. An investigation of a helix as a linear accelerator. K. JOHNSEN AND H. DAHL. *Beretn. Michelsens Inst. Vidensk.*, **14**, 48 *pp.* (*No.* 4, 1951).

A detailed analysis is made of the operation of a linear accelerator using a helix as resonator. The lines followed are similar to those followed by Walkinshaw and Wyllie. The losses and optimum dimensions for a practicable proton accelerator are determined. J. H. FREMLIN

537.534

332. The helix as a linear accelerator for protons. D. R. CHICK AND D. P. R. PETRIE. Letter in *Nature* [*Lond.*] **168**, 782–3 (*Nov.* 3, 1951).

Some design suggestions and data. J. J. WILKINS

537.534

333. A circuit for the operation of a synchrotron in conjunction with a Wilson cloud chamber. E. G. MUIRHEAD AND H. LICHTBLAU. *Aust. J. Sci. Res. A*, **4**, 432–4 (*Sept.*, 1951).

537.534 : 621.384.61

334. On deflection at $n = 1$ in the synchrocyclotron. D. R. HAMILTON AND H. J. LIPKIN. *Rev. Sci. Instrum.*, **22**, 783–98 (*Oct.*, 1951).

Discusses the theory of a possible method of synchrocyclotron beam deflection in which the orbits expand until the point of maximum $Hr(n = 1)$ is reached, after which the ions escape and spiral outward. These spirals should have a uniform starting radius and a small pitch in order to give deflection efficiency of the order of 100%; it is shown that this requires a flat maximum of Hr at $n = 1$, and small amplitude of radial oscillation. The radial and vertical oscillations of the beam and the couplings thereof are discussed in detail. It appears that the only field inhomogeneities which must be carefully minimized are those at $n = 1$ and $n = 0$. Limits on radial and vertical oscillations in the immediate vicinity of the ion source are set but the origins thereof in phenomena other than field inhomogeneity are not discussed. A.

537.534 : 621.384.62

335. New arrangements of the 1 100 kV accelerating equipment of the Istituto Superiore di Sanità. M. AGENO, M. CHIOZZOTTO AND R. QUERZOLI. *R.C. Ist. Super. Sanità*, **14**, 509–29 (*No.* 7, 1951) *In Italian.*

With an improved design of the Oliphant type ion source, in which the extractor voltage was raised from 25 to 50 kV, a beam current of 350 μA was obtained. 1 300 curie-equivalent of neutrons were obtained at 900 kV with a Li target, against a previously recorded maximum of 112 curie-equivalent. The constructional improvements made to the Philips accelerator tube and to the vacuum system as well as the layout of the new control system and building extensions, are described. F. J. MIRANDA

537.534 : 621.384.62 : 621.317.72

336. Modifications made to the generating voltmeter of the 1 100 kV equipment. M. CHIOZZOTTO AND R. QUERZOLI. *R.C. Ist. Super. Sanità*, **14**, 460–6 (*No.* 6, 1951) *In Italian.*

The causes of instability and long-term drift in the amplifier circuit were investigated and reduced. The instrument, which is part of the 1·1 MV equipment of the Ist. Super. Sanità of Rome, was calibrated with the $L_i^7\ (p, \gamma)B_e^8$ resonance. F. J. MIRANDA

537.534.72

337. Notes on the focusing properties of homogeneous magnetic sector fields. R. PERSSON. *Ark. Fys.*, **3**, 455–69 (*Paper* 24, 1951).

Fields with straight and circular boundaries are considered, using the graphical construction of Cartan [*J. Phys. Radium*, **8**, 453 (1937)]. Dispersion, aberration and the locus of mass foci are derived for symmetrical arrangements, and first- and second-order focusing conditions are given for these and for one asymmetrical case. Resolving power is calculated for systems using one fixed collector, and it is shown that, even in a special case with third-order focusing, the resolving power may decrease appreciably with increasing beam divergence. A mass spectrometer giving second-order focusing is described briefly. It uses 90° deflection with normal incidence, and the ion source may be used with solid or gaseous samples. Scanning is by voltage variation. T. G. PICKAVANCE

537.534.72

338. High resolution mass spectrometry. C. E. BERRY AND S. M. ROCK. Letter in *J. Chem. Phys.*, **19**, 1208–9 (*Sept.*, 1951).

Methods of improving on the resolution reported by Kniebes *et al.* [Abstr. 7023 (1951)] are discussed, and experimental results are given. J. J. WILKINS

537.534.72 : 539.164

339. Alpha-particle spectrograph. F. L. Reynolds. *Rev. Sci. Instrum.*, **22**, 749–52 (*Oct.*, 1951).

An alpha-particle spectrometer, using a 60° sector magnet capable of focusing alpha-particles of energies up to 14 MeV, is described. Description of the instrument, sample technique, focusing properties and current supplies are discussed. Transmission is about 0·01% of the total solid angle of the sample and with a resolution of 8 keV. A.

537.534.74

340. Elastic proton-deuteron scattering at 240 MeV. R. D. Schamberger. Letter in *Phys. Rev.*, **83**, 1276 (*Sept.* 15, 1951).

The experimental differential cross-section is given and compared with the values obtained using the Born approximation with three types of interaction.

J. HUGHES

537.534.74

341. Calculations concerning the measurement of the energy of charged particles by small angle scattering. H. S. Snyder. Letter in *Phys. Rev.*, **83**, 1068 (*Sept.* 1, 1951).

A graph is given, based on the calculations of Snyder and Scott [Abstr. 6262 (1949)], and Scott and Snyder [Abstr. 6553 (1950)], from which the energy of a charged particle can be determined from measurements of the small-angle scattering in the Ilford emulsion. J. HUGHES

537.534.74

342. Proton-proton scattering near 30 MeV. F. L. Fillmore. Letter in *Phys. Rev.*, **83**, 1252 (*Sept.* 15, 1951).

Refined measurements of angular distribution by the photographic plate method previously described by author [Abstr. 8053–4 (1950)]. W. J. SWIATECKI

537.534.8

343. Čerenkov radiation from protons and the measurement of proton velocity and kinetic energy. R. L. Mather. *Phys. Rev.*, **84**, 181–90 (*Oct.* 15, 1951).

High velocity protons ($\beta = 0{\cdot}68$) from the electrically deflected external beam of the 184 in cyclotron were sent through materials of high index of refraction (crystalline silver chloride and extra dense flint glass), and light was detected photographically with the intensity and angular distribution characteristics of Cherenkov radiation as predicted by Frank and Tamm. This is the first observation of this radiation from particles other than electrons and proves that the radiation is not a function of the mass of the particle. The heavier particle suffers less scattering and change of energy in the material and allows the highly directional character of the radiation to be observed. By removing the effects of chromatic dispersion with a suitable prism, the angular intensity distribution was reduced to a bell-shaped distribution about the predicted angle with a standard deviation of around 14 minutes of arc. This approaches the delta-function distribution derived by Frank and Tamm. The light was shown to be totally plane polarized in the direction predicted by Frank and Tamm. The possibility that the angular distribution of Cherenkov radiation could be used as an absolute measure of the velocity of the proton, and hence its energy, has been exploited and a device of great accuracy and simplicity has been developed for this measurement. The various effects which lower the resolution are discussed. An estimate of the accuracy with which the mean energy of the 340 MeV proton beam has been measured is $\pm 0{\cdot}8$ MeV. A.

537.534.8

344. Range energy relation for 340-MeV protons. R. Mather and E. Segrè. *Phys. Rev.*, **84**, 191–3 (*Oct.* 15, 1951).

The angle of emission of the Cherenkov radiation is used to find the velocity of a beam of protons. Their range is also measured and points of the range energy relation are obtained for energies near 340 MeV for Be, C, Al, Cu, Sn and Pb. The data are used to evaluate the average excitation energy I for these substances. A.

DISCHARGE TUBES . COUNTERS 537.54

537.541 : 621.387 : 621.316.722.9

345. The characteristics of some miniature high-stability glow-discharge voltage-regulator tubes. F. A. Benson. *J. Sci. Instrum.*, **28**, 339–42 (*Oct.*, 1951).

Three types have been studied. The results of short- and long-term tests to determine striking-voltage and running-voltage variations are presented. Figures are also given for temperature coefficient of running voltage and for the magnitudes and durations of the initial drifts. A.

537.542

346. Design and operation of a radio-frequency ion source for particle accelerators. C. D. Moak, H. Reese, Jr and W. M. Good. *Nucleonics*, **9**, 18–23 (*Sept.*, 1951).

R.f. excitation is used to produce an intense atomic hydrogen discharge in a Pyrex vessel. All electrodes are shielded from the discharge, as far as possible, by means of Pyrex screens to prevent recombination of H atoms at the metal surfaces. An extraction potential of 0–5 keV is applied to a W anode set in a short capillary at the top of the tube and the ion beam emerges through a $\frac{1}{16}$ in canal in the Al cathode. Very favourable ratios of H^+ to H_2^+ ions are obtained, if the Pyrex is carefully cleaned. Under typical operating conditions a source gave 1·15 mA of H^+, 0·08 mA of H_2^+ and 0·02 mA of H_3^+, with a gas consumption of 6 cm³/hr (at atmos. press.) and total power consumption of 500 W. The source can be operated for 30 hours without attention.

L. R. SHEPHERD

537.542 : 621.387

347. A cathode-type arc ion-source. E. H. Beach and W. C. Parkinson. Note in *Rev. Sci. Instrum.*, **22**, 697–9 (*Sept.*, 1951).

A brief description of an ion source with indirectly heated cathode originally designed for the Michigan 42 in cyclotron. No data on life, etc., are yet available. J. D. CRAGGS

537.542

348. The slow discharge in a non-self quenching Geiger–Mueller counter. W. E. RAMSEY. *J. Franklin Inst.*, **252**, 143–51 (*Aug.*, 1951).

A detailed study of the pulse build-up process in counters containing "simple" gases. The step-by-step processes occurring during a pulse due, e.g., to successive avalanches which can be formed in several ways, are illustrated by measurements of charge *v.* time for argon-oxygen counters. The interpretation of the repeated inflections in the charge/time curves is discussed. J. D. CRAGGS

537.542 : 621.387.424 : 621.389

349. An apparatus for the automatic display of counter characteristics. K. H. LAUTERJUNG AND L. NIKLAS. Note in *Z. Naturforsch.*, **6a**, 333–4 (*June*, 1951) *In German.*

Suitable circuits are outlined for displaying the counting characteristics of a G.M. tube directly on a cathode-ray tube. A. O. STANESBY

537.542

350. An extrapolation chamber: construction and use. T. E. BORTNER. *Nucleonics*, **9**, 40–3, 94 (*Sept.*, 1951).

A chamber with a variable distance between a β-emitting surface and a parallel collecting electrode with which one can determine, by extrapolation, the dose rate in an infinitesimal layer of air at the surface of the emitter, is described. A second chamber is also described in which the collector and emitting surface are contained in an air-tight enclosure, to permit measurements through a range of air pressures from about 10^{-3} min Hg to a few atmospheres. The use of this chamber for measurements of back-scattering from various elements from Be to Pb is discussed. L. R. SHEPHERD

537.542

351. Ionization pulses and charge transport mechanism in diamond. H. ESS AND J. ROSSEL. *Helv. Phys. Acta*, **24**, 247–78 (*No.* 3, 1951) *In French.*

Current pulses produced by ionizing radiations in two different diamond crystal counters are studied, both with respect to counting characteristics and to fundamental charge transport processes. For α-particles the maximum pulse size is proportional to the energy up to 5·3 MeV and for γ-rays up to 0·5 MeV. For fields $> 2\,000$ V/cm counting efficiency is 100% for α-particles but only 0·5% for γ-rays. Results suggest a domain structure in the crystals of linear dimensions $\sim 0{\cdot}5$ mm. Values of mobility-mean life time product and of conductivity are obtained separately for electrons and positive holes at 90, 200 and 290°K. Two different types of electron traps appear to be present due to impurities and to dislocations. For temperatures $\leqslant 200$°K and for fields $\geqslant 5\,000$ V/cm electron multiplication effects are observed, probably due to ionization of impurity centres by accelerated electrons. G. F. J. GARLICK

537.542

352. Instrumentation for I^{131} use in medical studies. B. CASSEN, L. CURTIS, C. REED AND R. LIBBY. *Nucleonics*, **9**, 46–50 (*Aug.*, 1951).

A scintillation counter using a calcium tungstate crystal and a lead collimator is described. This can detect the boundary of a region containing 0·2 μc of I^{131}/cm^2 with a resolution of $\frac{1}{4}''$. An automatic scanning and pen recording device is also described. This moves the counter gradually over an active region and maps out with pen traces the area containing the activity. L. R. SHEPHERD

537.542

353. Optimum distribution of counting times. W. E. BROWNING, JR. *Nucleonics*, **9**, 63–7 (*Sept.* 1951).

Expressions are derived for the times that should be occupied in counting background and sample plus background in order to minimize the total counting time required for the achievement of a given probable error. On the basis of these equations, charts are prepared, giving the optimum ratio of background to background plus sample counting times; the number of background and total counts to be taken; and the total counting time necessary to obtain a given percentage error. L. R. SHEPHERD

537.542 : 621.3.011 : 621.318.572

354. On the response to a voltage step-function of two cascaded differentiating circuits. W. D. HOWELL AND M. O. DEIGHTON. *Nat. Res. Coun. Can., Publ. No.* 2386, 12 *pp.* (1950).

A theoretical treatment of the general case of the problem where the loading effect of the second coupling on the first must be considered, e.g. the case of a Geiger counter coupled to an amplifier. Dimensionless response curves have been plotted for various chosen time-constants and loading factors, and the use of these is explained by examples. The cases where the two circuits are separated by an isolating stage, and where the time constants are appreciably different, are specially noted. Expressions are fully derived. A. J. KENNEDY

537.542 : 621.318.572

355. A sweep-type differential and integral discriminator. E. FAIRSTEIN. *Rev. Sci. Instrum.*, **22**, 761–5 (*Oct.*, 1951).

A circuit is described which can be used for obtaining the pulse-height distributions from scintillation counters, proportional counters, parallel-plate counters and other voltage pulse sources. Differential or integral curves can be plotted automatically [J. H. Parsons, "A sweep type alpha energy analyser," Rep. No. MonC-416, Oak Ridge, Tennessee (1947); J. H. Parsons, *Proc. Inst. Radio Engrs*, **37**, 564 (1949)] by the attachment of an electronic recorder, or can be obtained manually with the use of the built-in rate meter or an external scaler. The counting rate loss is approximately 1% per 100 000 counts per minute. The over-all drift in pulse-height setting, slit-width and counting rate zero is less than 1% per 24 hours. It will operate from any positive output amplifier whose rise time is 0·1 μsec or greater, and whose output is limited to 100 V. A.

537.542

356. A theory of diffusion cloud chambers. R. P. SHUTT. *Rev. Sci. Instrum.*, **22**, 730–6 (*Oct.*, 1951).

An attempt is made to understand quantitatively the effects of a given gas, gas pressure, vapour, ionization density and temperature distribution on the operation of diffusion chambers. An integral

equation is set up which takes into account diffusion of the vapour through the gas, removal of vapour by condensation, drop growth and the motion of the drops due to gravity. Temperature distributions necessary to produce tracks through a given depth of a chamber are calculated, applying to a wide variety of different conditions. For example, the average temperature gradient for operation with methanol and air at 1 atmos. or H at 10 atmos. exposed to sea-level cosmic radiation amounts to 3·6°C/cm while for air at 3 atmos. or H at 30 atmos. a gradient of 6·3°C/cm would be required. Because of the formation of uncharged drops at higher operating temperatures and because of the onset of semi-stable convection currents in the light gases operation is expected to become difficult with air at a pressure > 3 atmos. or H at a pressure > 30 atmos., or with ionization densities > 4 times sea-level cosmic radiation at 1 atmos. of air. A.

537.543 : 621.385.2

357. Influence of initial velocities on electron transit times in diodes. J. T. WALLMARK. Letter in *Phys. Rev.*, **84**, 598 (*Nov.* 1, 1951).

Note on calculation of the transit time of electrons with initial velocities in diodes having partial space charge, assuming nonhomogeneous velocity distribution. Z. F. WOJNAR

537.543 : 621.385.2

358. The transit time effect in a cylindrical diode. W. D. WOO. *J. Appl. Phys.*, **22**, 1333–9 (*Nov.*, 1951).

The impedance offered to a small superposed alternating current by a space-charge limited cylindrical diode is expressed in terms of the variational plate conductance, the transit-time angle and a group of constants which are functions of the ratio of the plate to cathode radii. The result covers the range of transit-time angle up to π radian and of the ratio of the plate to cathode radii from unity up to 100. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 539.132

359. Dissociation of hydrogen molecules by vibrational excitation and three-body recombination coefficient. E. BAUER. *Phys. Rev.*, **84**, 315–21 (*Oct.* 15, 1951).

The recombination of 2 atoms in the presence of a 3rd body is of importance in gas kinetics. The evaluation of its probability coefficient can be reduced to that of the reverse process, the dissociation of a molecule by collision, by means of the principle of detailed balance. Various mechanisms for dissociation are briefly discussed and an attempt is made to estimate the general order of magnitude of the cross-section for the excitation of a molecule into the vibrational continuum of its electronic ground state by carrying through a calculation for the dissociation of a H molecule by collision with an electron, proton and H atom. The Born approximation is not satisfactory for the heavy particles at low energies and a tentative method of correcting the cross-section by means of the exact one-dimensional problem is given. The resulting value of the cross-section for dissociation of a H molecule by a H atom is of the order 10^{-26} cm^2 at low energies; the 3-body recombination coefficient for the reverse process, namely, the recombination of 2 H atoms in the presence of a 3rd, is $\sim 10^{-43}$ cm^6/sec, which is very much smaller than the experimental value. A.

537.561

360. Observations on ionization and dissociation with a parabola mass spectrograph. H. EWALD AND A. HENGLEIN. Note in *Z. Naturforsch.*, **6a**, 463–4 (*Aug.*, 1951) *In German.*

A brief note on the use of the parabola method for the study of dissociation products in, e.g. methane. J. D. CRAGGS

537.561

361. The ionization potentials of the deuterated methanes. F. P. LOSSING, A. W. TICKNER AND W. A. BRYCE. *J. Chem. Phys.*, **19**, 1254–8 (*Oct.*, 1951).

The ionization potentials of methane, and of the four deuterated methanes, have been determined by electron impact using two 90° mass spectrometers with different types of sources. In addition, the ionization potentials of acetylene, deuterated acetylene, ethylene and deuterated ethylene have been measured. A simple empirical method is used to obtain values which are reproducible to $\pm 0{\cdot}02$ V. For the methanes the ionization potential is found to increase with the number of deuterium atoms in the molecule, with a difference of 0·18 V between the value for CH_4 and that for CD_4. Although this difference is found to be the same on each of the mass spectrometers, there is a difference of 0·11 V between the absolute values of the ionization potential as determined for CH_4 on the two instruments. In order to explain the difference between the ionization potentials of CH_4 and CD_4 on the basis of zero point energy differences, it is estimated that the force constants in the ionic state would need to have only about $\frac{1}{4}$ of their value in the ground state. Since this seems unreasonably low, it is suggested that the difference between the ionization potentials of the methanes, as measured by electron impact, may be caused, in part, by excess energy required for a "vertical" transition. A.

537.561 : 539.132

362. Studies of ionization efficiency. I. The determination of molecular appearance potentials using the mass spectrometer. J. D. MORRISON. *J. Chem. Phys.*, **19**, 1305–8 (*Oct.*, 1951).

The factors affecting the shape of ionization efficiency curves can be separated into two categories: those due to instrument design, and those depending on the molecular structure of the substance studied. By taking precautions to eliminate the former, details of individual fine structure can be detected and measured in the curves. The methods for the determination of appearance potentials in use at the present time are discussed, and the results for a number of substances measured by the principal methods are compared with spectroscopic ionization potentials. It is found that the critical slope method gives values

in all cases within 0·3 V of the spectroscopic figure, whereas the results of the other methods may be in error. A.

537.568

363. Analysis of ionic recombination including ion production during measurement. W. B. KUNKEL. *Phys. Rev.*, **84**, 218–21 (*Oct.* 15, 1951).

The differential equations governing the removal of ions by recombination in competition with time-dependent production or exchange processes are solved for three different important cases. Firstly, the gradual transformation from one type of carrier into another is discussed where the two types of carriers may have widely differing recombination coefficients. A relatively simple solution is given if the rate of decay of the first type is dominated by the rate of transformation. In the two other cases ion production caused by collisions of metastable atoms is considered. It is reasoned that the rate of production may either decrease exponentially just as the concentration of metastables or the rate of production may decrease quadratically if the removal of metastables is controlled by ionizing collisions between the metastables. Both cases can be solved rigorously. A.

537.568 : 538.566.2

364. Microwave determination of the probability of slow electrons in gases. A. V. PHELPS, O. T. FUNDINGSLAND AND S. C. BROWN. *Phys. Rev.*, **84**, 559–62 (*Nov.* 1, 1951).

A microwave method is given for determining the collision probability for momentum transfer for electrons in thermal equilibrium with a gas. An integral equation is developed which gives the ratio of the resistive and reactive components of the microwave conductivity in terms of the collision frequency for electrons with the gas atoms. Two approximate solutions are given for the collision frequency as a function of electron energy. An experimental procedure is described in which the conductivity ratio is determined from the shift in the resonant frequency and the change in conductance of a resonant cavity. Measurements are made during the decay of a pulsed discharge after the electrons have cooled to the gas temperature. Preliminary results are given for several gases. A.

537.568 : 538.566.2

365. Electron recombination and collision cross-section measurements in hydrogen. L. J. VARNERIN, JR. *Phys. Rev.*, **84**, 563–6 (*Nov.* 1, 1951).

Electron densities and mean collision cross-sections are deduced from measurements of the propagation constant for microwaves in a plasma. From the electron collision cross-section measurements, inferences are drawn concerning the slope of the cross-section electron velocity curve. The measurements are compared with those made by electron beam techniques. From the electron density measurements the recombination coefficient of hydrogen as a function of pressure is obtained. These data are interpreted on the basis of dissociative and ion-ion recombination. A.

537.568 : 539.132

366. Concerning the mechanism of electron-ion recombination. II. M. A. BIONDI. Letter in *Phys. Rev.*, **83**, 1078 (*Sept.* 1, 1951).

For Pt I, see Abstr. 7981 (1951). The recombination is a two-body process requiring the presence of molecular ions. To demonstrate this dependence the decay of electron density of He and Ne with 1% A was studied. J. JACOBS

537.58 : 541.183 : 621.389

367. An electronic method of detecting impurities in the air. G. PHILLIPS. *J. Sci. Instrum.*, **28**, 342–7 (*Oct.*, 1951).

Impurity concentrations in clean dry air of one part in 10^7 by weight of polar vapours or of one part in 10^4 by weight of non-polar vapours were measured in terms of changes in surface potential of a prepared plate. Changes of potential of the order of 10 μV were measured using a vibrating condenser technique and a selective phase-sensitive amplifier. The results suggest that whilst the adsorption is caused mainly by electrostatic attraction between the dipole and its induced image, a small contribution is also caused by van der Waals attractive forces. The possibilities of obtaining selective adsorption, and some of the practical applications, are discussed briefly. A.

537.582

368. The electronic temperature of oxide cathodes. Interpretation of experimental results. H. DORMONT. *J. Phys. Radium*, **12**, 710–16 (*July–Aug.–Sept.*, 1951) *In French.*

The emission current formula $I = I_s \exp(-eV/kT)$, where T is the thermodynamic temperature, is applicable to metallic cathodes but not to oxide cathodes. Here T must be replaced by an effective temperature $\theta > T$. A quantitative interpretation is given by assuming the presence of a potential barrier at the cathode surface; agreement with experiment is attained by assuming particular values for the dimensions of the barrier, taken to be rectangular.

E. P. WOHLFARTH

COSMIC RAYS 537.591

537.591

369. The momentum spectrum of cosmic-ray protons. C. B. A. MCCUSKER AND H. MESSEL. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 948–9 (*Oct.*, 1951).

The measured sea-level spectrum of cosmic-ray protons [Mylroi and Wilson, Abstr. 5518 (1951)] differs significantly from that deduced, using the nucleon-cascade treatment of Messel, from a pure power law primary spectrum fitted in the latitude sensitive region. J. G. WILSON

537.591

370. A magnetic orientation device. S. E. GOLIAN AND E. G. REILLY. *Rev. Sci. Instrum.*, **22**, 753–7 (*Oct.*, 1951).

A light weight, low current-drain system for the geomagnetic orientation of experimental equipment during a high-altitude balloon flight is here described. The system is specifically designed to keep nuclear emulsions oriented to within ± 5 degrees of a chosen geomagnetic heading. The error detector consists of a high impedance a.c. bridge, two of whose arms are

electrolytic resistance paths in ethyl alcohol. Deviation of a compass needle, immersed in the electrolyte, from a chosen "on-course" line unbalances the bridge. A correcting motor is started when the off course deviation unbalances the bridge to a sufficient predetermined extent. Direction of motor rotation is determined by the sense of the error. Quiescent power drain is 1·4 watts. Motor operation increases this drain by 4 watts. Flight analysis of orientation is made possible by an integrating camera. Some control characteristics are given. A.

537.591.1

371. The heavy nuclei of the primary cosmic radiation. P. S. Freier, G. W. Anderson, J. E. Naugle and E. P. Ney. *Phys. Rev.*, **84**, 322–31 (*Oct.* 15, 1951).

The atmospheric absorption of the flux of nuclei of charge $\geqslant 10$ has been obtained at $\lambda = 55°$N from a combination of flux measurements at different altitudes and at different zenith angles. The absorption, together with the collision cross-section, gives an energy spectrum consistent with the one measured by stopping particles and the latitude effect. The cross-section for collision of heavy nuclei is about three-fourths of the geometric cross-section. The energy spectrum can be represented by $NE > E_0 \propto 1/E_0\gamma$, where γ is 0·5 for energies above 0·8 BeV/nucleon. N is the number of nuclei with an energy greater than E_0 per nucleon. The flux measured at $\lambda = 30°$N gives an exponent $\gamma = 0·5$. At energies below about 0·75 BeV/nucleon the spectrum seems to get steeper. The flux of heavy nuclei measured on two night flights shows no significant difference from the day flux. Solar activity resulting in flares of importance 1 and 2 shows no measurable correlation with flux of heavy nuclei. A.

537.591.1

372. Erratum: High altitude measurements of the penetrating component intensity of cosmic radiation near the geomagnetic equator. A. S. Rao, V. K. Balasubrahmanyam, G. S. Gokhale and A. W. Pereira. Letter in *Phys. Rev.*, **84**, 364 (*Oct.* 15, 1951).

See Abstr. 7991 (1951).

537.591.1

373. A search for primary cosmic gamma-radiation. II. Low energy radiation above and within the atmosphere. G. J. Perlow and C. W. Kissinger. *Phys. Rev.*, **84**, 572–9 (*Nov.* 1, 1951).

For Pt I, see Abstr. 4499 (1951). Measurements are reported on the intensity of gamma-rays in the energy range 0·1 to 15 MeV, made in a series of rocket flights. The gamma-radiation was detected by anticoincidence in a bundle of Geiger counters. Registration of coincidences permitted a measurement of the intensity of charged particles, with the same geometry. The two quantities displayed a simultaneous maximum during flight, the counting rate of charged particles being ten times that of γ-rays at the maximum. A diurnal effect was looked for and not found. A theoretical treatment is given of the origin of the γ-radiation at the maximum. It is shown to be accountable for by bremsstrahlung of the electronic component and subsequent multiple Compton scattering. An estimate is given of the radiation due to annihilation of positrons followed by Compton scattering. This is shown to be only a few percent of the bremsstrahlung effect. After all corrections are applied a weak residual γ-radiation is found above the atmosphere. Arguments are given for identifying this as an albedo. Two types of albedo are considered, the first and more important is associated with back-scattering and is not calculated, while the second is due to the curvature of the earth. A calculation shows the latter to give 25% of the observed counting rate at 82 km. In conjunction with the conclusions of Pt I and with other evidence at higher energies, it is concluded that primary cosmic gamma-radiation contributes at most a very small fraction to the incoming cosmic-ray energy flux. A.

537.591.15

374. Photons in extensive showers. P. Bassi, A. M. Bianchi and C. Manduchi. Letter in *Nuovo Cim.*, **8**, 735–7 (*Sept.*, 1951) *In Italian.*

Twofold coincidences between counter trays of 1 200 cm² area, 4 m apart are used to select showers, and photons are detected in a transition layer below an anticoincidence shield. The transition effect saturates in about 20 g.cm^{-2} Pb. J. G. Wilson

537.591.15

375. The density of the penetrating particles in extensive cosmic-ray air showers. C. B. A. McCusker and D. D. Millar. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 915–20 (*Oct.*, 1951).

The ratio of penetrating particles to electrons in extensive cosmic-ray showers has been investigated experimentally at sea level. For the great majority of showers this ratio, in agreement with previous results, is found to be 2·5%. A small number of showers was detected in which the proportion of penetrating particles was much greater. A.

537.591.15

376. On the interaction in Pb of the secondaries produced in penetrating showers. G. M. Branch and G. Cocconi. Letter in *Phys. Rev.*, **84**, 146 (*Oct.* 1, 1951).

Two large rectangular cloud chambers, each containing 5, ½″ Pb plates and separated vertically by 6″ Pb, were used at altitude 3 260 m to measure the m.f.p. in Pb of penetrating shower secondaries. The observed m.f.p., $\sim 350 \pm 40$ g.cm^{-2} Pb is shown to be much too large, on account of interactions in Pb leading to no observable features, by study of the relative frequency of occurrence of interactions as a function of distance from the bottom of the various Pb plates. The correction factor is estimated to be $\sim 2·1$. J. G. Wilson

537.591.15

377. A dual cloud chamber study of extensive air showers. G. M. Branch. Letter in *Phys. Rev.*, **84**, 147 (*Oct.* 1, 1951).

Apparatus previously described (preceding Abstr.) was used to analyse penetrating particles (momentum, determined by scattering from shower axis, > 2 BeV/c) on the basis of interactions in the plates of the lower chamber. It is concluded that (26 ± 10)% of these particles belong to the strongly interacting N-component. J. G. Wilson

537.591.15

378. Nuclear bursts produced in the low energy nucleonic component of the cosmic radiations. J. A. Simpson, H. W. Baldwin and R. B. Uretz. *Phys. Rev.*, **84**, 332–9 (*Oct.* 15, 1951).

The production rate of low-energy nuclear bursts or stars has been measured as a function of altitude and geomagnetic latitude, λ, at 0°, 40°N and 52°N through 65°N. The measurements were obtained in aircraft using fast electron collection pulse chambers. Exponential absorption paths, $L_b(\lambda)$, for the nuclear burst or star producing radiation below ~ 200 g.cm^{-2} are $L_b(0°) = 214 \pm 7$; $L_b(40°) = 174 \pm 6$; $L_b(\geqslant 52°) = 164 \pm 14$ g.cm^{-2}. At an atmospheric depth of 312 g.cm^{-2} the latitude factor of increase from 0° to 52°N is $3{\cdot}11 \pm 0{\cdot}15$ on undisturbed days. The disintegration product fast neutrons have a latitude factor of $3{\cdot}30 \pm 0{\cdot}05$ under the same conditions. Integral pulse height distributions of nuclear bursts both at 0° and 52° are represented by $N_b = AV^{-2{\cdot}5 \pm 0{\cdot}1}$, where N_b is the number of burst pulses $>$ bias energy V. A similar study of local showers produced in Pb over the chambers at 0° and 52° shows a latitude factor of $< 1{\cdot}1$ and an exponential absorption of the shower producing radiations at all latitudes of 134 ± 7 g.cm^{-2}. The integral pulse height distribution for showers was $N_s = BV^{-2{\cdot}0 \pm 0{\cdot}15}$. From the measurements it is concluded that (*a*) the small stars are produced in atoms by inelastic collisions and knock-on processes by nucleons and the average number rather than the average energy of the stars produced by high-energy nucleons increases with increasing primary nucleon energy, (*b*) the small nuclear bursts are in equilibrium with the fast neutron production in the atmosphere below ~ 200 g.cm^{-2} and these small bursts account for almost the entire fast neutron intensity in the atmosphere, (*c*) these small stars and neutrons represent the low-energy limit of the nucleonic component, (*d*) the production rate of small nuclear stars is not strongly dependent on primary nucleon momentum above ~ 4BeV/c. A.

537.591.15

379. Penetrating showers produced in carbon and lead at sea level. W. Y. Chang and G. del Castillo. Letter in *Phys. Rev.*, **84**, 584 (*Nov.* 1, 1951).

Cloud chamber observations show that the multiplicities and angular distributions of the penetrating particles are similar for C and Pb. The results are thought to favour the multiple theory. E. P. George

537.591.15 : 519.2

380. Showers produced by low-energy electrons and photons. R. R. Wilson. *Nat. Bur. Stand., Appl. Math. Ser.*, *No.* 12, 1–3 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. The train of events following the impact of a low energy (< 300 MeV) photon or electron on a lead barrier is decided by means of a mechanical analogue procedure. Estimates of the distributions of the numbers of electrons reaching various depths in the lead are obtained. N. L. Johnson

537.591.3

381. The absorption of extensive showers in water. P. H. Barrett. *Phys. Rev.*, **84**, 339–44 (*Oct.* 15, 1951).

The absorption of the particles in extensive showers in water has been measured at 2 765 m elevation by detecting coincidences between trays of Geiger counters located under water. Coincidence rates have been measured with counter tray separations up to 5 m and at seven depths from 0 to 10 m of water. A theoretical calculation is shown to predict coincidence rates lower than those experimentally observed and further improvements in the calculations are suggested that might remove this discrepancy. If multiple cores exist in extensive showers, this experiment shows that they cannot be separated by more than 50 cm. The density spectrum and the spectrum of the number of particles in a shower have been calculated from the experimental results for elevations of 50 and 2 765 m. A.

537.591.5

382. The sea-level latitude variation of fast cosmic-ray neutrons. P. S. Gill and L. F. Curtiss. Letter in *Phys. Rev.*, **84**, 591 (*Nov.* 1, 1951).

This was measured between geomagnetic latitudes 3 and 18°N in India using B^{10} enriched BF_3 counters embedded in a paraffin moderator. A variation of 1·33 to 1 was observed. E. P. George

537.591.5

383. On a time variation of the penetrating cosmic radiation. P. Budini and G. Poiani. Letter in *Nuovo Cim.*, **8**, 732–4 (*Sept.*, 1951) *In Italian.*

537.591.5

384. Time and other variations in the intensity of cosmic ray neutrons. N. Adams and H. J. J. Braddick. *Z. Naturforsch.*, 6a, 592–8 (*Nov.*, 1951).

The barometer coefficient of cosmic-ray neutron production at sea level has been found to be $-9{\cdot}25\% \pm 0{\cdot}20$/cm Hg. It has been shown that there is no diurnal variation of neutron production of amplitude greater than about 0·4%. The effects of the large solar flare of Nov. 19, 1949, on cosmic-ray neutrons were much greater than on ionizing cosmic rays at sea level; the maximum factor of increase was more than 5 and the intensity remained measurably above normal for about 12 hours. A small increase of neutron intensity is found, statistically, to be correlated with a number of recorded radio fade-outs. It is suggested that neutron measurements are particularly suitable for studying temporal variations of cosmic rays. The latitude increase of cosmic-ray neutrons between geomagnetic latitude 54·5° and 56·5° was found to be about 2%. No certain increase was found between 56·5° and 59·6°. A.

537.591.8

385. Observations on the star-producing radiation at great altitudes. M. M. Addario Indovina. Letter in *Nuovo Cim.*, **8**, 729–31 (*Sept.*, 1951) *In Italian.*

Plates were exposed for 6 hours at 16 g.cm^{-2} residual pressure under 0 and 21 g.cm^{-2} graphite in north geomagnetic latitudes 31° and 57°, and the rates of different star types measured. While there is no significant transition effect in the graphite at 31° N for any stars, at 57° N there is a significant increase under the absorber of stars without minimum ionization tracks but not for stars with such tracks.

J. G. Wilson

537.591.8

386. Angular distribution of fragments of differing charge emitted in cosmic-ray nuclear explosions. J. CRUSSARD. *C.R. Acad. Sci.* [*Paris*] **233**, 611–13 (*Sept.* 10, 1951) *In French.*

Observations on stars in Ilford G5 emulsion, exposed at balloon altitudes, show that protons from stars cease to be emitted isotropically above about 30 MeV, α-particles above about 10 MeV per nucleon and heavier fragments above about 2–4 MeV per nucleon. The mechanism of emission of the heavier fragments is briefly discussed. J. G. WILSON

537.591.8

387. Cosmic-ray star production in argon at sea-level. W. W. BROWN AND E. W. HONES. Letter in *Phys. Rev.*, **83**, 1263 (*Sept.* 15, 1951).

About 100 stars have been observed in argon at 5 atmospheres at sea level in a fast ion chamber mounted to form part of a cloud chamber, and the rate of star production in argon is given.

J. G. WILSON

537.591.8

388. Behavior in Pb of the nucleonic component in the stratosphere. M. M. SHAPIRO AND A. F. GABRYSH. Letter in *Phys. Rev.*, **84**, 160 (*Oct.* 1, 1951).

Eastman NTB3 plates embedded in a lead absorber were flown for eight hours at pressures between 1 and 4 cm Hg. The star frequency passes through a maximum at 27 g.cm^{-2} Pb. E. P. GEORGE

537.591.8

389. Statistical significance of small samples of cosmic ray counts. V. H. REGENER. Letter in *Phys. Rev.*, **84**, 161 (*Oct.* 1, 1951).

Tables are given of the statistical uncertainties to be employed when the number of events is small, and the Gaussian is no longer a good approximation to the Poisson distribution. E. P. GEORGE

537.591.8

390. A search for charge-exchange scattering of π^+ mesons. R. WILSON AND J. P. PERRY. Letter in *Phys. Rev.*, **84**, 163 (*Oct.* 1, 1951).

The π^+-mesons were scattered in targets of Be and D_2O, and γ-rays from π^0 decay were looked for using two scintillation counter telescopes each with a Pb radiator. The coincidences observed were explicable in terms of the accidental background, giving an upper limit of $2\text{–}3\times10^{-29}$ cm^2 for the cross-section.

E. P. GEORGE

MAGNETISM 538

538.082

391. An experiment for the direct measurement of magnetostatic fields. E. EVERHART. Note in *Amer. J. Phys.*, **19**, 474–5 (*Nov.*, 1951).

538.114 : 548.7

392. Statistics of the simple cubic lattice. II. A. J. WAKEFIELD. *Proc. Camb. Phil. Soc.*, **47**, 799–810 (*Pt* 4, 1951).

The methods of Pt I [Abstr. 8836 (1951)] are used to calculate the temperature variation of specific heat of a ferromagnetic, with special reference to its behaviour near the Curie point. The results are compared with those of the Weiss model and others.

A. R. STOKES

538.122 : 621.3.013.2 : 621.318.2

393. The air-gap field of the permanent magnet. L. KNEISSLER. *Elektrotech. u. Maschinenb.* [*EuM*] **68**, 393–8 (*Sept.* 1, 1951) *In German.*

It is assumed that the magnetic field is due to a system of molecular currents which, for the purpose of investigating the total field, may be replaced by an equivalent exciting winding. In this case the volume of the magnet is considered as empty space and the total field of an externally excited system is the sum of the external and internally-produced fields. It is then shown that a magnetic material is characterized by the relation between the total field and that component of excitation which can be ascribed to the material itself. A graphical construction is derived for finding this relation. In the same way a method is shown for representing the effect of an air-gap in a toroid. This consists essentially in thinking of the removed portion of the material also as a reduction in the contribution to the total field of the molecular currents. By combining the two constructions the gap-field may be found (assuming no leakage) for a toroid with a given hysteresis curve. Finally an alternative approach is indicated on the basis of an ampere-turn calculation. S. C. DUNN

538.22, 537.311.3

Electrical conductivity and magnetic susceptibility of ovalene. *See Abstr.* 283

538.221

394. On the magnetic properties of pyrrhotite, chromium sulphide and alpha-hematite. K. YOSIDA. Letter in *Physica*, **17**, 794–6 (*Aug.*, 1951).

Suggests that the magnetic properties of pyrrhotite, chromium sulphide and α-hematite can be explained on the basis that in each case the materials of stoichiometric composition are antiferromagnetic and that excess of one element gives rise to ferromagnetism.

A. E. DE BARR

538.221

395. Ferromagnetism in Heusler's alloys. R. R. HEIKES. Letter in *Phys. Rev.*, **84**, 376–7 (*Oct.* 15, 1951).

Uses Heisenberg's and Zener's theories to estimate the ratio of the Curie temperatures of Cu_2MnAl and Cu_2MnIn from the observed ratio of the Mn–Mn distances. Zener's theory gives the better agreement with experiment. E. P. WOHLFARTH

538.221

396. Interatomic distances and ferromagnetism in spinels. R. S. WEISZ. Letter in *Phys. Rev.*, **84**, 379 (*Oct.* 15, 1951).

A new hypothesis, that spin interaction in ferromagnetic spinels is inversely proportional to the nearest neighbour distance (Me–O), is advanced to obtain the following results: (1) the strongest interaction in inverse spinels is between tetrahedrally and octahedrally situated cations; (2) ferromagnetism does not occur in normal spinels, e.g. $NiCr_2O_4$;

(3) a quantitative relation between the Curie temperature and interatomic distances is deduced for ferromagnetic spinels and NaCl-type antiferromagnetics.

E. P. WOHLFARTH

538.221

397. Magnetic susceptibility of manganese selenide. R. LINDSAY. *Phys. Rev.*, **84**, 569–71 (*Nov.* 1, 1951).

The susceptibility-temperature relation for the antiferromagnetic compound MnSe was measured over a range of temperatures between 70°C and −196°C. Evidence was found of a large thermal hysteresis and a dependence of susceptibility on field strength. A tentative theory is advanced to explain the thermal hysteresis in terms of three phases which possess different susceptibilities. A.

538.221 : 538.66

398. Ferromagnetic resonance in cobalt ferrite at high temperature. T. OKAMURA, Y. TORIZUKA AND Y. KOJIMA. Letter in *Phys. Rev.*, **84**, 372 (*Oct.* 15, 1951).

Resonance curves were obtained between 40°C and the Curie point (495°C), and the resonance field, maximum absorption and apparent line widths obtained as functions of temperature. Apparent g factors were also determined; at the Curie point $g = 2{\cdot}02 \pm 0{\cdot}06$, $H_{\text{resonance}} = 3\,300 \pm 100$ oersted.

E. P. WOHLFARTH

538.221 : 539.219

399. On the study of macroscopic magnetic texture. I. EPELBOIN. *C.R. Acad. Sci.* [*Paris*] **233**, 358–60 (*July* 30, 1951) *In French.*

Many factors such as stress, impurity and the effects of rolling or drawing affect the variation of magnetic quality in a strip of wire. It is suggested that these effects may be separated by the use of different heat treatments and by electrolytic removal of successive layers. A. E. DE BARR

538.222

400. Paramagnetic resonance in gadolinium ethylsulphate. B. BLEANEY, R. J. ELLIOTT, H. E. D. SCOVIL AND R. S. TRENAM. Letter in *Phil. Mag.*, **42**, 1062–4 (*Sept.*, 1951).

Experiments at 1·3 cm wavelength indicate that in the expression for the spin Hamiltonian the dominant term is one with pronounced axial symmetry (P_2^0), not with cubic symmetry as in previous interpretations. The constants in the Hamiltonian were deduced from measurements with the field both parallel and perpendicular to the hexagonal axis, and g values were deduced by two different means. E. P. WOHLFARTH

538.222

401. Paramagnetism of cerium ethylsulphate at low temperatures. G. S. BOGLE, A. H. COOKE AND S. WHITLEY. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 931–2 (*Oct.*, 1951).

Reports susceptibility and resonance measurements on single crystals of $Ce(C_2H_5SO_4)_3 . 9H_2O$. The spectroscopic splitting factors of the levels with $J_z = \pm\frac{1}{2}, \pm\frac{5}{2}$ were measured for H parallel and perpendicular to the z axis. The energy separation between the two levels was deduced from the relative intensities of the resonance lines. Theoretical relations for $\chi_\perp$ and $\chi_\parallel$ are in good agreement with experiment. E. P. WOHLFARTH

538.222

402. The paramagnetism of cerium ethylsulphate: Theory. R. J. ELLIOTT AND K. W. H. STEVENS. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 932–3 (*Oct.*, 1951).

Gives a theoretical discussion of the experimental results [see preceding Abstr.]. These are interpreted by assuming given values for the crystal field parameters [see Abstr. 4534 (1951)]. E. P. WOHLFARTH

538.222

403. Microwave paramagnetic spectra of iron alum salts. C. A. WHITMER AND R. T. WEIDNER. Letter in *Phys. Rev.*, **84**, 159 (*Oct.* 1, 1951).

Resonance absorption spectra at 4°, 77° and 293°K show a splitting of the ground state of the iron ion incompatible with purely cubic symmetry. J. JACOBS

538.222

404. Paramagnetic resonance absorption in organic free radicals. A. N. HOLDEN, W. A. YAGER AND F. R. MERRITT. Letter in *J. Chem. Phys.*, **19**, 1319 (*Oct.*, 1951).

Summarizes measurements of resonance absorption at 24 000 Mc/s. Tabulates half-peak widths, expressed as magnetic field change, together with values of Landé splitting factor. G. F. LOTHIAN

538.222

405. Size and thermal conductivity effects in paramagnetic relaxation. J. EISENSTEIN. *Phys. Rev.*, **84**, 548–50 (*Nov.* 1, 1951).

The Casimir-du Pré thermodynamic theory of paramagnetic relaxation is generalized by taking account of the thermal conductivity of the paramagnetic salt. The case of a spherical specimen in a constant temperature bath is considered. One finds that infinitely many times are required to characterize the relaxation when a magnetic field is suddenly applied. The alternating current susceptibility is calculated and is shown to contain terms depending on the size and thermal conductivity of the specimen. A limited comparison of the theory with experimental data is made. A.

538.224 : 539.13

406. The diamagnetic anisotropy of large aromatic systems. III. Structures with hexagonal symmetry. R. MCWEENY. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 921–30 (*Oct.*, 1951).

For Pt I–II, see Abstr. 3641 (1951). The molecular orbital method is employed in calculations of the diamagnetic anisotropies of a series of highly condensed aromatic systems having hexagonal symmetry and containing up to 54 C atoms. A new method of calculation is introduced in which the π-electron susceptibility of the whole molecule is determined by an integration, no knowledge of the unperturbed energy levels being necessary: the inclusion of overlap between adjacent atomic orbitals is shown generally to have little effect on the calculations. The results are compared with those calculated using the method of Pauling: this semi-classical method is found to be quite misleading when applied to large molecules

or to molecules possessing stray C–C bonds. Qualitative valence bond considerations are advanced in support of these conclusions, and certain general results are tentatively suggested. A.

538.24

407. The mechanism of magnetization discontinuities. T. Hofbauer and K. M. Koch. *Z. Phys.*, **130**, 409–14 (*No.* 4. 1951) *In German.*

Experiments on specimens with preferred orientations (rolled Fe–Ni sheet steel) indicate that an auxiliary field of frequency higher than that of the main field has the effect of initiating and propagating Barkhausen jumps and of increasing the remanent and saturation magnetizations. E. P. WOHLFARTH

538.24

408. On the spontaneous magnetization and the Curie point of very thin ferromagnetic films. A. Drigo. Letter in *Nuovo Cim.*, **8**, 498–501 (*July*, 1951) *In Italian.*

Reports new measurements, by a torsion balance method, on electro-deposited films of Fe, Co and Ni from 10 to 5 000 atomic layers thick. The Curie temperature decreases with decreasing thickness essentially as predicted by Klein and Smith [Abstr. 4528 (1951)], but the spontaneous magnetization at fixed (room) temperature is in each case greater than predicted. An empirical change in the theoretical curves leads to better agreement. F. F. ROBERTS

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.551 : 621.317.733

409. A note on the solution and synthesis by inspection of a.c. bridges. P. B. Fellgett. *J. Sci. Instrum.*, **28**, 316–17 (*Oct.*, 1951).

It is shown that a.c. bridges may be combined into a complex bridge in such a way that the resultant bridge balances when all the component bridges are balanced. Examples show how the balance condition of a complex bridge may be found by inspection, and how a bridge suitable for a given application may be synthesized. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 545.8 : 621.396.615

410. Construction of an Hertzian oscillator and its application to organic analysis. H.-A. Sack and B. Sack. *J. Rech. Cent. Nat. Rech. Sci.*, **3**, 325–31 (*No.* 15, 1951) *In French.*

The apparatus comprises a feeding circuit, the oscillator (including the receptacle for the sample), and a galvanometer indicating circuit, and it shows the impedance or changes in impedance of the sample in terms of the galvanometer reading (R). It is used qualitatively to characterize various organic laboratory solvents in terms of R; to analyse binary solvent mixtures by the use of calibration curves relating R and the % composition; and, by a method analogous to conductimetric analysis, to follow neutralization reactions and to determine their end-points. Examples, including the use of non-aqueous solvents, are given. J. GRANT

538.565 : 621.392.52 : 621.396.645

411. A tunable shunt selector-rejector for audio amplifiers. O. G. Villard, Jr. *Rev. Sci. Instrum.*, **22**, 726–9 (*Oct.*, 1951).

A means for adding, without circuit modification or wiring changes, continuously tunable band-pass or band-reject selectivity to existing audio amplifiers is described. This takes the form of an external electronic circuit connected to the amplifier by means of a wire attached to the anode pin of one valve, and a common a.c. ground connection. The arrangement is useful for temporarily rejecting or amplifying a particular frequency. A.

538.566 : 532.59 : 519.283

Wave propagation in hydrodynamics and electrodynamics. *See Abstr.* 26

538.566 : 621.315.61 : 621.396.11 : 621.392

412. The influence of magnetic fields upon the propagation of electromagnetic waves in artificial dielectrics. E. R. Wicher. *J. Appl. Phys.*, **22**, 1327–9 (*Nov.*, 1951).

An effect corresponding to the Faraday effect in natural dielectrics is predicted for a class of artificial dielectrics because of the existence of a Hall effect in the metallic components of the structure. A formula for Verdet's constant as a function of element polarizability and Hall coefficient is obtained. The resonance shift to be expected in a cavity resonator, filled with an artificial dielectric, and subjected to a strong magnetic field, is calculated. Prospects for the application of these effects are briefly considered. A.

538.566

413. Exact theory of the diffraction of a plane e.m. wave by a perfectly conducting circular obstacle and by a circular opening in a perfectly conducting plane screen. Numerical results. W. Andrejewski. Letter in *Naturwissenschaften*, **38**, 406–7 (*No.* 17, 1951) *In German.*

Numerical results worked out from the Meixner–Andrejewski formulae [see Abstr. 7378 (1950)] in the case of normal incidence are compared with experimental results by Andrews [Abstr. 2118 (1947)]. Agreement is reasonable, given the difficulty of the measurements. This investigation appears to confirm the validity of Meixner's boundary conditions.

L. PINCHERLE

538.566

414. Scattering of electromagnetic waves from two concentric spheres. A. L. Aden and M. Kerker. *J. Appl. Phys.*, **22**, 1242–6 (*Oct.*, 1951).

A solution is given for the problem of the scattering of plane electromagnetic waves from a sphere with a concentric spherical shell. The solution is general, and under appropriate conditions is reduced to the well-known solution for scattering from a single sphere. A.

538.566

415. Magneto-optics of an electron gas for guided microwaves: propagation in rectangular waveguide. L. GOLDSTEIN, M. LAMPERT AND J. HENEY. Letter in *Phys. Rev.*, **83,** 1255 (*Sept.* 15, 1951).

At frequencies at which the guide supports one single mode, large attenuation is observed when the gyrofrequency of the electrons approximates to the signal frequency and large reflections immediately on either side of the gyroresonance. L. PINCHERLE

538.566 : 621.392.26

416. The susceptance of a thin iris in circular wave guide with the TM_{01} mode incident. K. L. DUNNING AND R. G. FELLERS. *J. Appl. Phys.*, **22,** 1316–20 (*Nov.*, 1951).

Certain waveguide boundary value problems can be formulated in terms of lumped-constant circuits and distributed-constant transmission lines. Equivalent circuit voltages and currents can be introduced as measures of the transverse electric and magnetic fields. Making use of these concepts and Schwinger's integral equation method, the susceptance of a thin circular iris in circular cylindrical waveguide with the TM_{01} mode incident is discussed and calculated. Results are compared with experimental data. A.

538.566 : 621.396.671

417. General formulation for calculation of shaped beam antennas. A. S. DUNBAR. Letter in *J. Appl. Phys.*, **22,** 1217 (*Sept.*, 1951).

Gives a generalization of the method used by Chu, for the calculation of a cylindrical reflector and a line source. G. D. SIMS

538.566 : 621.396.671

418. The necessary number of elements in a directional ring aerial. H. L. KNUDSEN. *J. Appl. Phys.*, **22,** 1299–1306 (*Nov.*, 1951).

It is shown that an odd number of elements is more favourable than an even number in approximating the array characteristic of a similar ring aerial with infinitely many elements. It was previously shown by Page that a similar statement applies to an azimuthly omnidirectional, fading-reducing, concentric ring aerial; this result is contained as a special case in this investigation. The present paper deals especially with the case in which the principal direction of the aerial array is horizontal; the theory for this case is illustrated by a numerical example. A.

538.566 : 621.396.671

419. General theory of symmetric biconical antennas. S. A. SCHELKUNOFF. *J. Appl. Phys.*, **22,** 1330–2 (*Nov.*, 1951).

Presents the input admittance of a symmetric biconical aerial of an arbitrary angle as the limit of a certain sequence of functions. The first term of this sequence approaches the exact expressions for the input admittance as the cone angle approaches either zero or 90°. For this reason it is conjectured that this term represents a good first approximation for all angles. A.

538.566 : 621.396.677

420. An experimental investigation of the dielectric rod antenna of circular cross section excited in the dominant mode. C. W. HORTON AND C. M. MCKINNEY, JR. *J. Appl. Phys.*, **22,** 1246–9 (*Oct.*, 1951).

The radiation pattern and the gain were measured for four series of dielectric aerials of circular cross-section, excited by a TE_{11} mode in a circular metallic waveguide at 9 275 Mc/s. Only one parameter was changed in each series of rods so that the effect of this on the pattern and gain could be studied. Measurements of gain are presented for two further series of rods in which the length is varied. The measurements showed that a polystyrene rod of length $6\lambda_0$ and constant cross-section has maximum gain and best pattern for a diameter of approximately $2\lambda_0$. On the other hand, when the taper of a Lucite rod was varied while the length and the maximum diameter were held constant at $6\lambda_0$ and $0{\cdot}87\lambda_0$, respectively, the gain and the pattern behaviour improved as the minimum diameter was decreased to zero. It is shown that losses in the dielectric produce a significant decrease in the gain. A.

538.566.2 : 537.568

Microwave determination of electron collision and recombination probability. *See Abstr.* 364–5

538.566.2 : 621.396.11

421. Tropospheric propagation beyond the horizon. J. FEINSTEIN. Letter in *J. Appl. Phys.*, **22,** 1292–3 (*Oct.*, 1951).

An explanation is suggested in terms of waves partially reflected as a result of the refractive index gradient in the troposphere. A method of estimating the field strength to be expected is briefly indicated. W. J. G. BEYNON

538.566.2 : 621.396.11.08

422. A new measurement of the velocity of radio waves. C. I. ASLAKSON. *Nature* [*Lond.*] **168,** 505–6 (*Sept.* 22, 1951).

The Shoran radar technique was used to measure 15 distances, all of which were tied to the first-order triangulation network of the U.S.A. Comparison of the radar and geodetic distances gives a value for velocity of 299 794·2 ± 1·9 km/s. L. ESSEN

538.566.3

423. Radio wave paths in the ionosphere. E. ARGENCE. *C.R. Acad. Sci.* [*Paris*] **233,** 607–8 (*Sept.* 10, 1951) *In French.*

Continuation of earlier paper [see Abstr. 8379 (1951)] on the influence of the earth's magnetic field on ionospheric ray paths. See also Abstr. following. W. J. G. BEYNON

538.566.3

424. Some calculations of ray paths in the ionosphere. S. K. H. FORSGREN. *Trans Chalmers Univ. Techn* [*Gothenberg*] *No.* 104, 22 *pp.* (1951).

A theoretical study of the effect of the earth's magnetic field on ionospheric ray paths for the case of vertical incidence reflections at Kiruna (latitude 67° 50′ N). W. J. G. BEYNON

538.566.3 : 621.396.11

425. The effect of the earth's magnetic field on short-wave communication by the ionosphere. G. MILLINGTON. *Proc. Instn Elect. Engrs, Pt IV,* **98,** 1–14 (*Oct.*, 1951) [*Monograph No.* 1].

For abstract see Abstr. 4560 (1951).

538.566.3 : 621.396.11

426. On Bailey's theory of amplified circularly polarized waves in an ionized medium. R. Q. Twiss. *Phys. Rev.*, **84**, 448–57 (*Nov.* 1, 1951).

It is shown that the growing waves, which Bailey interprets as amplified waves, can only be excited by reflection and it is argued that this theory can explain neither the excess radiation observed from sunspots nor the excess noise observed in discharge tubes. However, power amplification is possible in a drifting ionized medium under certain ideal conditions which are analysed. A.

538.569.3

427. Interpretation of the curve of dielectric absorption ϵ'' of adsorbed water in the kilometer range. I. Relations and numerical results. G. Carpéni. *C.R. Acad. Sci.* [*Paris*] **233**, 158–60 (*July* 9, 1951) *In French.*

The curve of ε'' against temperature T shows two bands I and II; the position of I (−100°C) is independent of the water content E, that of II varies with E. There is a linear relation between E and (i) the heights h_I and h_{II} of I and II, (ii) the temperature of the maximum in curve II. Also $h_I + h_{II} = \text{constant} = h_m \ldots$ [relation (1)]. S. J. GREGG

538.569.3

428. Interpretation of the curve of dielectric absorption ϵ'' of adsorbed water in the kilometer range. II. Consequences: determination of the specific surface [S] and the rupture point of the adsorbent. G. Carpéni. *C.R. Acad. Sci.* [*Paris*] **233**, 249–51 (*July* 16, 1951) *In French.*

See preceding Abstract. A third band (III) has a peak (height h_m) at 88°C; h_m is a maximum when E is just enough (E_m) to cover the adsorbent with a monolayer of water molecules. E_m can be obtained by extrapolation and thence S can be calculated. When $E > E_m$ bands I and II appear. Relation (1) holds if the adsorbed water is "ordered," and $h_I + h_{II} < h_m$ if it is "disordered." The water content E_c at which (1) breaks down gives the "point of rupture" of the adsorbent. S. J. GREGG

538.569.3

429. Interpretation of the curve of dielectric absorption ϵ'' of adsorbed water in the kilometer range. G. Carpéni. *C.R. Acad. Sci.* [*Paris*] **233**, 309–11 (*July* 23, 1951) *In French.*

The results of Parts I and II are discussed.

S. J. GREGG

THEORY OF SOLID STATE 539.11

539.11 : 537.311.33

Effect of the change in lattice parameter on the width of the forbidden energy zone according to Kronig and Penney's one-dimensional lattice model. *See Abstr.* 288

539.11 : 548.7 : 536.424.1

430. Nature of the transition in carbon tetrabromide. J. G. Marshall, K. R. Hart and L. A. K. Staveley. Letter in *Nature* [*Lond.*] **168**, 519–20 (*Sept.* 22, 1951).

From specific heat and other considerations, it is concluded that above and below the 46·9°C transition the molecules perform torsional oscillations and do not rotate freely in the high temperature form.

J. JACOBS

MOLECULAR STRUCTURE 539.13

539.13

431. A theoretical treatment of the meta-orienting effect of some substituents in the benzene nucleus. F. L. J. Sixma. Letter in *J. Chem. Phys.*, **19**, 1209–10 (*Sept.*, 1951).

The influence of the electric field of the substituent on the energy of the transition state is calculated, and differences in localization energy are equated to those of activation. J. JACOBS

539.13

432. Directed valence in As_4 and P_4. M. Machima. Letter in *J. Chem. Phys.*, **19**, 1216 (*Sept.*, 1951).

The *s-p-d* trigonal hybridized bond orbitals at 60° are stronger than the *p-d* ones hitherto proposed. The unshared pair occupies the 4th hybrid function.

J. JACOBS

539.13

433. Nuclear magnetic shielding in fluorine and hydrogen compounds. H. S. Gutowsky and C. J. Hoffman. *J. Chem. Phys.*, **19**, 1259–67 (*Oct.*, 1951).

Measurements of the nuclear magnetic shielding of F^{19} and H^1 are reported for a number of their respective binary covalent compounds. The applied fields required for the F^{19} and H^1 nuclear magnetic resonances, at fixed frequency, vary in these compounds over a range of 3·98 and 0·122 gauss, respectively, at fields of about 6 365 gauss. These ranges are of the same order of magnitude as the theoretical internal diamagnetic corrections for the unbound F and H atoms. The dependence of nuclear magnetic shielding on the electronic structures of the molecules is discussed qualitatively and some general correlations indicated. One such correlation is that the magnetic shielding of the F^{19} nucleus decreases with increasing electronegativity of the atom to which the F is bonded. This and other correlations differ in degree for the proton. The differences may arise from the relatively greater importance of the diamagnetic shielding term for the proton. Specific information regarding molecular and electronic structure is provided in several instances. The tetragonal pyramid structure for IF_5 is confirmed and a similar structure demonstrated for BrF_5. The appearance of double F^{19} resonance lines in PF_5, IF_5 and BrF_5 indicates nonequivalent electronic distributions in the structurally distinguishable bonds. The measurements were facilitated by a large permanent magnet, the design and field homogenization of which are described. A.

539.13

434. A mobile electron model for aromatic molecules. K. Rüdenberg and R. G. Parr. *J. Chem. Phys.*, **19**, 1268–70 (*Oct.*, 1951).

A three-dimensional mobile electron model for unsaturation electrons in aromatic molecules is described which allows leakage of electrons across

rings and takes aromatic atoms explicitly into account. The model contains the free electron model as a limiting case. Applications to the spectra of cata-condensed hydrocarbons are discussed. A.

539.13 : 535.343–14 : 548.74

435. The structure of trifluoromethyl acetylene from the microwave spectrum and electron diffraction pattern. J. N. Shoolery, G. R. Shulman, W. F. Sheehan, Jr, V. Schomaker and D. M. Yost. *J. Chem. Phys.*, **19**, 1364–9 (*Nov.*, 1951).

Measurements, in the microwave region, of the $J = 3 \rightarrow 4$ rotational transitions of trifluoromethyl acetylene and several of its isotopic modifications have been made, and the moments of inertia, I_B (in a.m.u.-Å^2), have been found for the ground vibrational state: for CF_3CCH, $175{\cdot}61_3$, $CF_3C^{13}CH$, $177{\cdot}02_4$, $CF_3CC^{13}H$, $181{\cdot}30_2$, and for CF_3CCD, $187{\cdot}46_2$. Three lines corresponding to $J = 3 \rightarrow 4$ transitions of CF_3CCH in the excited vibrational state $v_{10} = 1$, and two lines corresponding to $v_{10} = 2$ and $v_{10} = 3$, have also been measured and interpreted according to Nielson's theory of *l*-type doubling in symmetric tops. From Stark effect measurements at different electric field strengths the dipole moment of CF_3CCH in the ground vibrational state has been found to be $2{\cdot}36 \pm 0{\cdot}04$ Debye units. For the ground vibrational state the microwave data lead to the following bond distances: C—H, $1{\cdot}056 \pm 0{\cdot}005$ Å; C≡C, $1{\cdot}201 \pm 0{\cdot}002$ Å. The C—C and C—F distances were calculated from the measured moments of inertia for several assumed values of the FCF angle. Electron diffraction experiments were also made, and the intensity curves calculated for the assumed microwave models were compared with the observed visual curve. From the combination of microwave and electron diffraction results the best agreement was obtained with the following set of parameters: ∠ FCF, $107{\cdot}5° \pm 1°$; C—C, $1{\cdot}464 \pm 0{\cdot}02$ Å; C—F, $1{\cdot}335 \pm 0{\cdot}01$ Å. A.

539.132

436. Conjugated compounds. III. Spectra and ionization in polyenes and polymethines by a finite difference method. N. S. Bayliss and J. C. Rivière. *Aust. J. Sci. Res. A*, **4**, 344–58 (*Sept.*, 1951).

For Pt II, see Abstr. 1223 (1951). Periodic potential energies were calculated for π-electrons along the molecular axes of butadiene and three polymethines $NH_2 - (CH = CH)_n - CH = NH_2^+$, using $Z_C' = 1{\cdot}0$ and $Z_N = 2{\cdot}0$ or $1{\cdot}5$ as the respective effective nuclear charges of the carbon and nitrogen nuclei. The Schroedinger equation was solved by finite differences, and with two restricted and self-consistent parameters, good agreement was obtained with observed ionization energies, band frequencies and band intensities. The Brillouin zone effect is discussed, and also the screening in conjugated compounds. The use of an iteration procedure for the solution of eigenvalue problems by finite differences is described. A.

539.132

437. The effect of variation of Z upon the theoretically computed energy levels of benzene. H. Shull and F. O. Ellison. Letter in *J. Chem. Phys.*, **19**, 1215–16 (*Sept.*, 1951).

The calculations used various Z values, including many centre integrals but omitting interaction of configurations, and support theoretical assignments of symmetry. J. Jacobs

539.132

438. LCAO molecular orbital computation of resonance energies of benzene and butadiene, with general analysis of theoretical *versus* thermochemical resonance energies. R. S. Mulliken and R. G. Parr. *J. Chem. Phys.*, **19**, 1271–8 (*Oct.*, 1951).

The decrease in π_x-electron energy for the change from a Kekulé to a proper benzene structure is computed purely theoretically by the method of anti-symmetrized products of MO's (molecular orbitals), in LCAO approximation, using Slater $2p\pi_x$ AO's (atomic orbitals) of effective charge $3{\cdot}18$, and assuming a C–C distance of $1{\cdot}39$ Å. The result ($73{\cdot}1$ kcal/mole) is a theoretical value for the gross (vertical) resonance energy of benzene taken for constant C–C distances of $1{\cdot}39$ Å. To make a comparison with the net or ordinary empirical resonance energy, several corrections to the latter are required. The principal one is for the "compression energy" required to compress the single and stretch the double bonds of the Kekulé structure from normal single and double-bond distances to $1{\cdot}39$ Å. The others (not hitherto clearly recognized) involve hyperconjugation and related effects. The corrections are discussed and their magnitudes estimated, but a reliable value can be obtained only for the compression energy. Allowing for this alone, the computed net resonance energy is $36{\cdot}5$ kcal. This agrees, within the uncertainties due to the omitted correction terms, with the value ($41{\cdot}8$ kcal) of the "observed" resonance energy Δ based on thermochemical data. Here Δ is the departure of the actual heat of formation ΔH_f of benzene from the value given by a standard formula for nonresonating hydrocarbons. A new standard formula containing corrections for the mutual effects of neighbouring C–C bonds is given. The analysis serves to clarify hitherto existing obscurities in what is meant by "resonance energy." An analysis of the nature and significance of "nonresonating" structures (like for example Kekulé benzene) is also included, using He_2, 1,3 butadiene, and benzene as examples. The gross resonance energies of cis- and trans-1,3-butadiene are computed by the same method. A.

539.132

439. Sum rules for the vibration frequencies of isotopic molecules. J. C. Decius and E. B. Wilson, Jr. *J. Chem. Phys.*, **19**, 1409–12 (*Nov.*, 1951).

The squares of the frequencies of isotopically related molecules obey certain simple sum rules. Whenever there exists a chemical exchange reaction involving only isotopic variations of a single type of molecule, such that the reaction is balanced at each atomic position of the molecule, then a relation of identical form exists between the sums of the squares of the frequencies. Thus $\Sigma\nu^2(H_2O) + \Sigma\nu^2(D_2O) = 2\Sigma\nu^2(HDO)$ and $\Sigma\nu^2(N^{14}H_3) + \Sigma\nu^2(N^{15}D_3) = \Sigma\nu^2(N^{14}D_3) + \Sigma\nu^2(N^{15}H_3)$. If, as in the latter example, the molecules all have the same symmetry, the sum rule may be applied separately to each factor of the secular equation. When forms of lower symmetry appear (as in the example involving the water molecule), symmetry factoring may or may not

J. OF I.

be possible. In such cases it is necessary to employ certain group-theoretical considerations; the possible factoring is not in general identical with that appropriate for the product rule. Examples of the application of the sum rule are given, involving the acetylene, water, methane and hydrocyanic acid molecules. The existence of higher-order isotope rules, intermediate between the sum and product rules, is pointed out. A.

539.132

440. Experimental determination of even-odd character of excited electronic states of molecules with a center of symmetry. J. R. Platt. *J. Chem. Phys.*, **19**, 1418–19 (*Nov.*, 1951).

Even-even transition intensities increase with monosubstitution but decrease with opposed disubstitution. Even-odd transition intensities which increase with monosubstitution must increase further with opposed disubstitution. Determination of parity in this way may settle disputed assignments. Thus the ${}^1A_{1g} - {}^1E_{2g}$ π-transition of benzene is probably at 1 700 Å. The first singlet absorption of naphthalene is ${}^1A_{1g} - {}^1B_{1u}$ or ${}^1A_{1g} - {}^1B_{2u}$ and cannot be ${}^1A_{1g} - {}^1A_{1g}$ even though the cancellation of transition matrix elements (from configuration interaction, in the one-electron approximation) gives it an intensity and vibrational structure similar to those in a forbidden transition. The visible bands of porphine are even-odd ($a_{2u} \rightarrow e_g {}^1A_g - {}^1Q_u^0$). Intensities in the 2 100 Å transition of phenyl derivatives are being remeasured to settle its assignment in benzene, since existing data give conflicting results. A.

539.132 : 538.224

441. Quantum calculation of the diamagnetic anisotropy of organic molecules. II. Principal groups of aromatic hydrocarbons. G. Berthier, M. Mayot and B. Pullman. *J. Phys. Radium*, **12**, 717–23 (*July–Aug.–Sept.*, 1951) *In French.*

For Pt I, see Abstr. 8875 (1951). The mean diamagnetic susceptibility is calculated as a function of the resonance integral, with and without nearest-neighbour overlap. The results are related to some π-electron properties of the ground state. J. JACOBS

539.133

442. Molecular constants of the ground state of the I_2 molecule. D. H. Rank and W. M. Baldwin. Letter in *J. Chem. Phys.*, **19**, 1210–11 (*Sept.*, 1951).

Greater precision has improved earlier interferometer measurements by an order of magnitude.

J. JACOBS

539.133

443. Definition of charges, dipole moments and transition moments after configurational interaction is introduced. R. Daudel and A. Laforgue. *C.R. Acad. Sci.* [*Paris*] **233**, 623–5 (*Sept.* 10, 1951) *In French.*

A derivation of μ and λ and their simplifications if a centre of symmetry exists. J. JACOBS

539.133

444. Molecular quadrupole moments of N_2 and O_2. C. Greenhow and W. V. Smith. *J. Chem. Phys.*, **19**, 1298–1300 (*Oct.*, 1951).

Molecular orbital calculations of the quadrupole moments of N_2 and O_2 have been made. Models assuming 20% $s - p$ hybridization for N_2 and 5–10% $s - p$ hybridization for O_2 give calculated quadrupole moments agreeing with those deduced from microwave line broadening data ($0{\cdot}27e \times 10^{-16}$ e.s.u. for N_2 and $< 0{\cdot}09e \times 10^{-16}$ e.s.u. for O_2). A.

539.133

445. The molecular structure of methyl alcohol. D. G. Burkhard and D. M. Dennison. *Phys. Rev.*, **84**, 408–17 (*Nov.* 1, 1951).

A qualitative discussion of the near and far i.r. spectrum of methyl alcohol shows that the rotational states, including the hindered rotation, may be well represented by a model consisting of a rigid hydroxyl and a rigid methyl group. These groups may perform a mutual rotation with respect to each other about the symmetry axis of the methyl group subject to a hindering potential which is assumed to have the form $V = \frac{1}{2}H(1 - \cos 3x)$ where x is the angle of mutual rotation. A series of lines in the microwave spectrum, discovered by Hershberger and Turkevich, have recently been measured with great accuracy by Coles who also determined their Stark splitting. The positive identification of these lines leads at once to an estimate of the barrier height H. The wave equation for the rotation of methyl alcohol is obtained and the matrix elements of the Hamiltonian are evaluated using the wave functions derived by Koehler and Dennison on the basis of a simplified model. Diagonalizing the Hamiltonian yields the energy levels which are found to predict correctly the principal features of the microwave spectrum. A quantitative comparison serves to fix the moments and product of inertia to have the values, $A = 34{\cdot}28$, $C_1 = 1{\cdot}236$ and $D = -0{\cdot}107$ all times 10^{-40} g.cm^2. The two components of the electric moment are determined, $\mu_{||} = 0{\cdot}893$ and $\mu_{\perp} = 1{\cdot}435 \times 10^{-18}$ e.s.u. A relation is obtained between the barrier height H and the moment of inertia C_2 of the methyl group about its symmetry axis. Assuming C_2 to be equal to the methane moment of inertia, then $H = 380$ cm^{-1}. If, in addition to taking a methane-like structure for the methyl group, it is assumed that the OH distance is the same as in water, namely 0·958 Å, one finds that (1) the CO distance is 1·421 Å, (2) the symmetry axis of the methyl group lies between the O and H atoms with the O displaced 0·084 Å from it and (3) the COH bond angle is 110° 15′. This latter angle is 5° 44′ greater than the apex angle in water vapour. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.15

446. Modern conceptions of the structure of matter. J. Cockcroft. *Proc. Instn Elect. Engrs, Pt I*, **98**, 301–8 (*Nov.*, 1951).

The forty-second Kelvin Lecture. Structure of nuclei; nuclear energy and nuclear forces; scattering experiments; meson theory; experimental detection of mesons; origin of the elements.

539.15 : 53.081.6

447. Radiative corrections to the hyperfine structure and the fine structure constant. N. M. KROLL AND F. POLLOCK. Letter in *Phys. Rev.*, **84**, 594 (*Nov.* 1, 1951).

Evaluation of these to order α^2 gives a correction to the magnetic self-energy of an electron which is 12 times the estimate of Bethe and Longmire [Abstr. 2043 (1949)] and results in a change of the calculated α^{-1} from 137·043 to 137·036. W. J. SWIATECKI

539.152.1

448. The relation between the nuclear quadrupole moments of copper isotopes. G. BECKER. *Z. Phys.*, **130**, 415–26 (*No.* 4. 1951) *In German.*

Theoretical and experimental details of work already published [Abstr. 6385 (1951)].

E. P. WOHLFARTH

539.152.1

449. The systematics of nuclear energies. A. E. S. GREEN. Letter in *Phys. Rev.*, **83**, 1248 (*Sept.* 15, 1951).

A semi-empirical binding energy formula is suggested in terms of 4 simple key functions.

W. J. SWIATECKI

539.152.1

450. Low excited states of nuclei and the quasi-atomic model. L. J. KOESTER, H. L. JACKSON AND R. K. ADAIR. Letter in *Phys. Rev.*, **83**, 1250 (*Sept.* 15, 1951).

Qualitative correlation between the observed energy levels of He^5, Li^5, F^{17}, N^{13}, Al^{25} and calculations using the single particle model with spin-orbit coupling and a "more singular than oscillator" potential. W. J. SWIATECKI

539.152.1

451. The spins and parities of the 3·7–3·9 MeV doublet in C^{13}. J. ROTBLAT. Letter in *Phys. Rev.*, **83**, 1271 (*Sept.* 15, 1951).

A detailed study of the protons from the $C^{12}(d, p)C^{13}$ reaction reveals 2 levels in C^{13} at 3·683 and 3·884 MeV. Using the stripping theory of Butler spins $\frac{1}{2}$ or $\frac{3}{2}$ odd parity and $\frac{3}{2}$ or $\frac{5}{2}$ even parity respectively are deduced.

W. J. SWIATECKI

539.152.1

452. On certain applications of the Fermi–Thomas model to the nucleus. H. R. PANETH. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 937–8 (*Oct.*, 1951).

Comments on the Fermi–Thomas model and nuclear shell theory which show the prediction of magic numbers by use of the Fermi model of the nucleus [Abstr. 8119 (1951)] to be invalid.

R. H. DALITZ

539.152.1

453. Classification of N^{13} levels by partial wave analysis of proton scattering from C^{12}. H. L. JACKSON AND A. I. GALONSKY. *Phys. Rev.*, **84**, 401–8 (*Nov.* 1, 1951).

The nature of the excited levels in N^{13} between 2·24 and 5·64 MeV was investigated by analysing the $C^{12}(p, p)C^{12}$ data of Goldhaber and Williamson. To carry out the analysis, the partial wave phase shifts were related to the level parameters by means of one-level dispersion theory. Then by successive approximations of the level parameters, the partial wave expansion of the differential cross-section for elastic scattering was fitted to the experimental curve. The analysis leads to the conclusion that the lower scattering anomaly is due to an $S_{\frac{1}{2}}$ level at 2·379 MeV above the ground state, and that the higher scattering anomaly results from a $P_{\frac{3}{2}}$ level at 3·501 MeV and a $D_{\frac{5}{2}}$ level at 3·549 MeV. Neither experiment nor analysis indicates any other levels in the range considered. It is shown that no other simple level assignment can account for the observed scattering cross-section. The appearance of levels with $j = l + \frac{1}{2}$ instead of $j = l - \frac{1}{2}$ supports Mayer's hypothesis of level inversion in nuclei. The widths and energies of the levels obtained from the present analysis are in partial agreement with the values obtained from the (p, γ) reaction. A.

539.152.2

454. On the magnetic moments of mirror nuclei. S. GALLONE AND G. SALVETTI. Letter in *Nuovo Cim.*, **8**, 502–3 (*July*, 1951) *In Italian.*

A theoretical study of the magnetic behaviour of a model in which an odd nucleon with given orbital and spin momentum moves in the field of a core with given angular momentum and gyromagnetic ratio. The deviations from the Schmidt lines are worked out as functions of all these parameters. L. PINCHERLE

539.152.2

455. On the magnetic moments of odd-odd nuclei. I. TALMI. Letter in *Phys. Rev.*, **83**, 1248 (*Sept.* 15, 1951).

These moments are close to the values calculated with the assumption that the two odd nucleons move in a central field and that the *jj*-coupling scheme applies. On the other hand, magnetic moments of odd-even nuclei deviate markedly from the Schmidt lines. It is pointed out that the apparent contradiction between these two facts disappears upon consideration of the mutual compensation of the changes in the magnetic moments due to the odd proton and odd neutron. L. PINCHERLE

539.152.2

456. On the spin and quadrupole moment of Cl^{36}. C. M. JOHNSON, W. GORDY AND R. LIVINGSTON. Letter in *Phys. Rev.*, **83**, 1249 (*Sept.* 15, 1951).

From h.f.s. observations the value 2 was confirmed for the nuclear spin. The quadrupole moment was found to be $-0{\cdot}0168 \pm 0{\cdot}0001\ 10^{-24}\ cm^2$.

L. PINCHERLE

539.152.2

457. A steady-state transient technique in nuclear induction. R. BRADFORD, C. CLAY AND E. STRICK. Letter in *Phys. Rev.*, **84**, 157 (*Oct.* 1, 1951).

Details are given for analysing the nuclear induction signal in the presence of a repeating pulse of strong r.f. signal. Field inhomogeneities and nuclear relaxation times, T_2 even if $> 10^{-3}$ sec may be determined.

D. H. WHIFFEN

539.152.2

458. Nuclear spin of actinium 227. F. S. TOMKINS, M. FRED AND W. F. MEGGERS. Letter in *Phys. Rev.*, **84**, 168 (*Oct.* 1, 1951).

Found to be $\frac{3}{2}$ from interferometer measurements on the h.f.s., of 15 lines. J. HUGHES

539.152.2

459. On nuclear quadrupole moments. R. Sternheimer. *Phys. Rev.*, **84**, 244–53 (*Oct.* 15, 1951).

The correction to nuclear quadrupole moments on account of the quadrupole moment induced in the electron shells has been obtained by solving the Schroedinger equation for the perturbed core wave functions for Li, Al and Cl. The correction factor by which the average $(1/r^3)$ over the valence electron function in the equation for the quadrupole coupling should be multiplied to take account of the induced effect is 1·11, 0·83 and 0·68 respectively. The previously described Thomas–Fermi calculation of this effect has been carried out for 13 additional elements. A.

539.152.2

460. A comment on the validity of the Bloch formulation for the interpretation of nuclear magnetic resonance phenomena. E. Strick, R. Bradford, C. Clay and A. Craft. Letter in *Phys. Rev.*, **84**, 363–4 (*Oct.* 15, 1951).

Off-resonance side-bands observed in $MnSO_4$ using the technique of Bradford, Clay and Strick (repeated pulses of the external resonating magnetic field) are well accounted for by an appropriate solution of the Bloch equations of motion. W. J. Swiatecki

539.152.2

461. The magnetic moment of As^{75}. S. S. Dharmatti and H. E. Weaver, Jr. Letter in *Phys. Rev.*, **84**, 367 (*Oct.* 15, 1951).

Nuclear magnetic resonance in a solution of Na_2HAsO_4 in NaOH gave $\mu(As^{75}) = +1{\cdot}4347 \pm 0{\cdot}0003$ nuclear magnetons. W. J. Swiatecki

539.152.2

462. Evidence for non-additivity of nucleon moments. R. G. Sachs and M. Ross. Letter in *Phys. Rev.*, **84**, 379–80 (*Oct.* 15, 1951).

This is found in dipole transitions in a number (7) of nuclear isomers. Certain restrictions on the form of the interaction moment can be deduced assuming rather pure shell model states. W. J. Swiatecki

539.152.2, 535.338.333

Isotope shift in the spectrum of Os I and the magnetic moment of Os^{189}. *See Abstr.* 175

539.152.2 : 539.166.2 : 548.7

Nuclear alignment of Co^{60}. *See Abstr.* 644

539.153

463. Some investigations on the stability of the negative helium ion. E. Holøien. *Arch. Math. Naturv.*, **51**, 81–9 (*No.* 1–2, 1951).

Calculations by the variational method are made to determine possible stable states of the ion. The $(2s)(2p)^2\ ^4P$ state of He^- is found to be stable with respect to the loss of one electron. J. Hughes

539.153

464. Calculation of the Rydberg correction for singly excited lithium *p*- and *d*-states. E. Holøien. *Arch. Math. Naturv.*, **51**, 1–19 (*No.* 1–2, 1951).

The method used in the treatment of the excited states of He is extended to the three electron problem of the Li atom. Approximate spin and orbital functions are used in a variational procedure and the Rydberg corrections due to Coulomb attraction, screening, exchange, polarization and polarization-exchange effects are worked out. For the lower states agreement with experiment is satisfactory. For higher states experimental data are unreliable. L. Pincherle

539.153

465. Energy level systems of electrostatic complexes of the transition metals containing one *d*-electron. F. E. Ilse and H. Hartmann. *Z. phys. Chem.*, **197**, 239–46 (*Aug.*, 1951) *In German.*

Group theory and perturbation theory have been used to obtain the energy levels. The selection rules for light absorption have also been obtained. P. T. Landsberg

539.153

466. Electrodynamic displacement of atomic energy levels. R. Karplus, A. Klein and J. Schwinger. Letter in *Phys. Rev.*, **84**, 597 (*Nov.* 1, 1951).

Theory extended to include effects of order $Z\alpha^2$. The improved theoretical value of the "Lamb shift" in hydrogen is 1057·75 Mc/s, compared with the experimental value of 1062 ± 5 Mc/s. J. Hughes

539.153.4

467. Radiative corrections to the intensitites for hydrogenlike atoms. T. Tati. Letter in *Phys. Rev.*, **84**, 150 (*Oct.* 1, 1951).

The effect of these on the transition probabilities is calculated for single photon emission, in non-relativistic approximation, using the Hamiltonian of W. Pauli and M. Fierz [*Nuovo Cim.*, **15**, 167 (1938)]. A lifetime of 2×10^4 sec is obtained for $2s_{\frac{1}{2}} \rightarrow 2p_{\frac{1}{2}}$. W. J. Swiatecki

539.153.4 : 535.338

468. Configuration interaction in the Pb III spectrum. J. N. P. Hume and M. F. Crawford. *Phys. Rev.*, **84**, 486–94 (*Nov.* 1, 1951).

The Slater and the configuration perturbation parameters were evaluated for configurations of Pb III by fitting the calculated to the observed term values. The wave functions of 52 levels were determined in terms of the (*LS*) functions, and for many of the levels were found to be linear combinations of the (*LS*) functions of two or more configurations. The *g*-values, hyperfine structure interval factors and isotope shifts evaluated from the precise wave functions are in excellent agreement with the observed values. Thus the theory gives an internally consistent explanation of the spectroscopic properties. Since the isotope shifts were calculated as a field effect the agreement shows that the specific mass effect is relatively unimportant for heavy elements. The values of the shift and hyperfine structure interaction constant for the 6*s* electron obtained from this analysis are 0·50 cm^{-1} and 2·60 cm^{-1}, respectively. A.

539.153.4 : 537.122

Fine structure of positronium. *See Abstr.* 267

539.155.2

469. On the distribution of errors in the photometric determination of isotope abundances. J. Mattauch. *Z. Naturforsch.*, **6a**, 391–6 (*July*, 1951) *In German.*

The available data on isotope abundance in various elements, determined photometrically from mass spectrograph plates, show a consistently increasing

scatter among the values as the ratio of line intensities increases. The amount of scatter is $\sqrt{2}$ times that expected on simple error theory, which suggests that only half the observations are subject to statistically independent errors. It is suggested that this may be due to uniform areas of sensitivity on the photographic plates instead of the random inhomogeneity assumed.

S. T. HENDERSON

539.155.2

470. Enriched stable isotopes: five years of production and use. C. P. KEIM. *Nucleonics*, **9**, 5–9 (*Aug.*, 1951).

177 isotopes of 43 elements have been enriched in milligram or gram amounts by the Oak Ridge electromagnetic separators. Some of the technical problems of electromagnetic separation of isotopes are considered briefly and a table of typical isotopes processed and the degree of enrichment attained, is given.

L. R. SHEPHERD

539.155.2 : 536.75

471. The thermodynamic efficiency of a continuously operating process for the separation of isotopes. G. DICKEL. *Z. phys. Chem.*, **197**, 197–227 (*Jan.*, 1951) *In German.*

A theoretical investigation into the loss of efficiency due to irreversible processes. It has been found that the attainable efficiency has a maximum in many cases. Actual processes appear to fall short of this maximum by factors of about 100.

P. T. LANDSBERG

539.155.2 : 550.93

472. I^{129} and the age of the elements. H. E. SUESS AND H. BROWN. Letter in *Phys. Rev.*, **83**, 1254 (*Sept.* 15, 1951).

Criticism of Katcoff, Schaeffer and Hastings [Abstr. 5696 (1951)]. The radiogenic origin of Xe^{129} (from I^{129}) is not certain, and the low abundance of Xe^{128} and Xe^{130} relative to Xe^{129} may be due to "shielding" by Te^{128} and Te^{130}. See also Abstr. 7211 (1949), 1201 (1950).

A. O. STANESBY

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08 : 550.839

473. A portable detecting and measuring instrument for radioactivity. A. TANARRO AND R. SEGOVIA. Note in *An. Real Soc. Esp. Fis. y Quim.*, **47A**, 193–6 (*July–Aug.*, 1951) *In Spanish.*

A description of an apparatus suitable for geological prospecting.

L. PINCHERLE

539.16.08 : 621.389

474. An electronic device for the study of short-lived [$t_{\frac{1}{2}} \sim 0{\cdot}1$ sec] radioactivities. G. VENDRYES AND H. SAVINELLI. Letter in *J. Phys. Radium*, **12**, 759–60 (*July–Aug.–Sept.*, 1951) *In French.*

Two asymmetrical square waveforms (50 c/s) separated slightly in time are used to control irradiation by a 900 kV ion accelerator, and the counting of the resultant activity, in such a way that the radiations directly produced by the ion beam are not counted, while counting begins as quickly as possible after the irradiation ceases.

A. O. STANESBY

539.16.08 : 778.3

475. Photographic X- and gamma-ray dosimetry. M. EHRLICH AND S. H. FITCH. *Nucleonics*, **9**, 5–17 (*Sept.*, 1951).

Discusses the design of a photographic film dosimeter with a response independent of photon energy above 100 kV and covering a useful dosage ratage of 10 000 r. The wide dosage range is achieved by mixing four emulsions, sensitive to different parts of the range. Energy independence is obtained by the use of a filter of Pb and Sn which matches the greater sensitivity of the film to photons of lower energies by a corresponding reduction in intensities due to absorption. The film is surrounded by a bakelite container with walls thick enough to stop external secondary electrons produced by 10 MeV betatron X-rays. The filter is wrapped around the container. The calibration of the dosimeter is described.

L. R. SHEPHERD

539.162

476. A note on the theory of directional correlation. K. ALDER. Letter in *Phys. Rev.*, **83**, 1266 (*Sept.* 15, 1951).

Falkoff and Uhlenbeck's formula for the correlation of two successive emissions of any nuclear particles is modified by means of an expansion in Legendre polynomials. Various parameters of the theory are worked out.

L. PINCHERLE

539.162

477. Angular correlation in magnetic fields. K. ALDER. Letter in *Phys. Rev.*, **84**, 369–70 (*Oct.* 15, 1951).

This is formulated for the consecutive emission of two particles and the limiting cases of weak and strong fields calculated. The case of a field perpendicular to the plane of the two particles is especially useful. See also Abstr. 510 (1952).

W. J. SWIATECKI

539.162

478. Asymptotic behavior of angular correlation functions. W. OPECHOWSKI. Letter in *Phys. Rev.*, **84**, 590 (*Nov.* 1, 1951).

It is shown that for large angular momenta of the initial state of the system and of the particle emitted in the first transition, the correlation function is independent of the nature and properties of the particle.

W. J. SWIATECKI

539.163

479. Contribution to the study of nuclear decay schemes. Disintegration of As_{33}^{76}, and of Mo_{42}^{99} in equilibrium with Tc_{43}^{99*}. N. MARTY-WOLLMAN. *Ann. Phys.* [*Paris*] **6**, 662–729 (*July–Aug.*, 1951) *In French.*

Decay schemes and the processes of β- and γ-emission are discussed, and a 180° β-spectrometer described in detail. The β-spectrum of As^{76} is broken into 4 partial spectra with end-points at 3·15, 2·57, 1·5 and 0·4 MeV. γ-rays of energy 1·25 and 0·56 MeV were observed. The ratio $\beta^+/\beta^- < 0{\cdot}5\%$. The β-spectrum of Mo^{99} is also complex, with an end-point at $1{\cdot}250 \pm 0{\cdot}015$ MeV. γ-rays of energy 745, 780 and 850 keV were observed from Mo^{99} in equilibrium with Tc^{99*}. The latter reverts to the ground state with the emission of a partially converted γ-ray

of energy 139 ± 1 keV. Decay schemes are proposed and discussed. B. ROSE

539.163

480. Properties of plutonium-243. J. C. SULLIVAN, G. L. PYLE, M. H. STUDIER, P. R. FIELDS AND W. M. MANNING. Letter in *Phys. Rev.*, **83**, 1267 (*Sept.* 15, 1951).

A β-activity with a $\frac{1}{2}$-life of 5·0 hr and $E_{\beta max} \sim 0{\cdot}5$ MeV was obtained by prolonged neutron irradiation of Pu^{239}, and attributed to Pu^{243}. A. O. STANESBY

539.163

481. Properties of the isotope Pu^{243}. S. G. THOMPSON, K. STREET, JR, A. GHIORSO AND F. L. REYNOLDS. Letter in *Phys. Rev.*, **84**, 165 (*Oct.* 1, 1951).

See also preceding Abstract. The β-emitter Pu^{243} was obtained by irradiating a sample of Pu containing Pu^{242} with neutrons (cross-section for $Pu^{242}(n, \gamma)Pu^{243}$ was $\sim 10^2$ barns) and was examined in a β-spectrograph and by absorption methods, giving $E_{max} = 0{\cdot}39$ MeV, and γ-rays of 0·095 and 0·12 MeV; the $\frac{1}{2}$-life was 5·0 ± 0·2 hr. A. O. STANESBY

539.163

482. The decay of Sr^{87m}, Y^{87m}, and Y^{87}. L. G. MANN AND P. AXEL. *Phys. Rev.*, **84**, 221–30 (*Oct.* 15, 1951).

The 2·8 hr Sr^{87m}, 80 hr Y^{87} and 14 hr Y^{87m} activities were studied by means of a thin lens beta-ray spectrometer, Geiger counters in coincidence and scintillation crystals. The following results were obtained: (*a*) Sr^{87m}: $t_{\frac{1}{2}} = 2{\cdot}80 \pm 0{\cdot}05$ hr, γ-energy = 390 ± 2 keV, K conversion coefficient = 0·24 ± 0·05, ratio of K to $(L+M)$ conversion = 6·9 ± 0·4; (*b*) Y^{87}: $t_{\frac{1}{2}} = 80{\cdot}0 \pm 1$ hr, decays to Sr^{87m}, more than 99% K-capture, 0·7 MeV positrons, gamma-ray follows K-capture with energy = 485 ± 3 keV and K conversion coefficient = $3{\cdot}2 \pm 0{\cdot}7 \times 10^{-3}$; (*c*) Y^{87m}: $t_{\frac{1}{2}} = 14 \pm 1$ hr, γ-energy = 384 ± 3 keV (definitely different from Sr^{87m} γ-ray), K conversion coefficient = 0·24 ± 0·07. These data are compared with the predictions of the theories of internal conversion, nuclear isomeric transitions, shell structure and beta-decay. The results are incorporated in a decay scheme and probable spin and parity assignments are given. Conventional beta-decay theory and the spin-orbit coupling shell model give incompatible assignments to the energy levels in Y^{87}. A.

539.163

483. Characteristics of some radionuclides of tungsten, rhenium, and osmium formed by second-order thermal neutron capture. M. LINDNER. *Phys. Rev.*, **84**, 240–4 (*Oct.* 15, 1951).

The identification and characteristics of several beta-emitting nuclides are reported. The half-life of W^{188} is 65 days, Os^{194} about 700 days, while Re^{189} might be either of two isotopes having half-lives of about 150 days or of at least five years. The mass assignment of W^{181} has been confirmed in view of its presence in thermal-neutron-irradiated tungsten. Re^{188} was found to have a half-life of 16·9 hr. No gamma-radiation could be found by absorption measurements to be associated with the 18 hr Ir^{194} daughter of Os^{194}. Thermal-neutron activation cross-sections are reported for most of the nuclides. A.

539.163.1

484. Half-life of Li^8. W. RALL AND K. G. MCNEILL. Letter in *Phys. Rev.*, **83**, 1244 (*Sept.* 15, 1951).

The Li^8 was produced by the reaction $Li^7(d, p)$ and the observed half-life was 0·825 ± 0·02 sec, in disagreement with earlier work, e.g. Abstr. 187 (1948). B. ROSE

539.163.1

485. The specific alpha-radioactivity of Pu^{240}. E. F. WESTRUM, JR. Letter in *Phys. Rev.*, **83**, 1249 (*Sept.* 15, 1951).

This has been determined, from a measurement of the relative specific activities and isotopic compositions of several samples of plutonium, to be 6 240 ± 120 yr (but see Abstr. following). B. ROSE

539.163.1

486. Half-life of plutonium-240 by determination of its uranium-236 daughter. M. G. INGRAM, D. C. HESS, P. R. FIELDS AND G. L. PYLE. Letter in *Phys. Rev.*, **83**, 1250 (*Sept.* 15, 1951).

From the ratios U^{235}/U^{236} and Pu^{240}/Pu^{239}, determined mass-spectrographically on a single sample, the half-life was found to be 6 580 ± 40 yr (but see preceding Abstr.). B. ROSE

539.163.2

487. The K-capture/positron branching ratio in Cu^{64}. E. PLASSMANN AND F. R. SCOTT. Letter in *Phys. Rev.*, **84**, 156 (*Oct.* 1, 1951).

Measured in a 180° magnetic spectrometer by comparing the relative intensities of the K Auger electrons and the positrons. The K-capture/positron ratio to the ground state is 2·07 ± 0·20 in excellent agreement with the theoretically predicted value of 2·08. J. HUGHES

539.163.2

488. Half-lives of Cu^{66}, Cu^{64}, Fe^{59} and Ce^{144} [and Fe^{55} and Pm^{147}]. R. P. SCHUMAN AND A. CAMILLI. Letter in *Phys. Rev.*, **84**, 158 (*Oct.* 1, 1951).

Precise measurements using a flow proportional counter gave the following $\frac{1}{2}$-lives: Cu^{66}: 5·12 ± 0·05 min; Cu^{64}: 12·74 ± 0·07 hr; Fe^{59}: 45·1 ± 0·2 d; Ce^{144}: 282 ± 3 d. Preliminary values were also found for Fe^{55}: 3·0 ± 0·15 yr; Pm^{147}: 2·6 ± 0·2 yr. A. O. STANESBY

539.163.2

489. The decay scheme of Cu^{66}. G. FRIEDLANDER AND D. E. ALBURGER. *Phys. Rev.*, **84**, 231–4 (*Oct.* 15, 1951).

The decay scheme of 5·2 min Cu^{66} has been determined by beta-ray spectrometer, scintillation spectrometer and coincidence measurements. It is found that 9·2 ± 1% of the beta-ray transitions go to an excited state of Zn^{66} whose lifetime is less than 10^{-7} sec and are followed by 1·044 ± 0·010 MeV gamma-rays. The remaining 91% of the beta-decays go to the ground state of Zn^{66}, with an upper energy limit of 2·63 ± 0·02 MeV. This high energy beta-group appears to have the allowed spectrum shape. Both beta-decays have ft values characteristic of

allowed transitions. Spin and parity assignments for Cu^{66} and for the 1·044 MeV level of Zn^{66} are made, and some features of the decay of Ga^{66} to Zn^{66} are discussed. A.

539.163.2

490. Radiations from Ge^{69}. C. M. HUDDLESTON AND A. B. SMITH. *Phys. Rev.*, **84**, 289–91 (*Oct.* 15, 1951).

The radiations from Ge^{69} (39·6 hr) have been studied with the help of a magnetic lens spectrograph. Gamma-rays of energies 0·090, 0·388, 0·576, 0·870, 1·12, 1·340, 1·610 MeV have been found. The positron spectrum is complex and can be analysed into three groups of end-point energies 1·215 MeV (88%), 0·610 MeV (10%) and 0·220 MeV (2%). Coincidence studies have also been made. A tentative energy level scheme is presented. A.

539.163.2

491. Disintegration of Ta^{180}. H. N. BROWN, W. L. BENDEL, F. J. SHORE AND R. A. BECKER. *Phys. Rev.*, **84**, 292–5 (*Oct.* 15, 1951).

The modes of decay of 8 hr Ta^{180} have been studied by means of a magnetic spectrometer and coincidence-absorption techniques. It is found that approximately 21% of the decays involve either of two negative beta-particles in transitions to states of W^{180}. The remainder of the decays proceed by means of *K*-capture to at least two different states of Hf^{180}. No positrons are observed. Very prominent conversion lines attributed to a 93 keV gamma-transition in Hf^{180} are observed, in addition to a weaker line considered to be associated with a 102 keV gamma-ray in W^{180}. Auger electrons are also present. The multipolarity of the 93 keV gamma-ray is thought to be electric quadrupole. A.

539.163.2

492. The decay of I^{125}. G. FRIEDLANDER AND W. C. ORR. *Phys. Rev.*, **84**, 484–6 (*Nov.* 1, 1951).

The decay of I^{125} has been investigated. The nuclide decays entirely by orbital electron capture with a half-life of $60·0 \pm 0·5$ d. An upper limit of 5×10^{-4} was set for the fraction of I^{125} decaying to the 58 d isomer of Te^{125}. By proportional counter and coincidence measurements it was established that all transitions go to the 35·4 keV level of Te^{125}, which is a $d_{3/2}$ state. The I^{125} ground state can be assigned a $d_{5/2}$ configuration. The ratio of L_1 to K electron capture was determined to be between 0·18 and 0·45, with a most probable value 0·30. From these ratios, the energy difference between the ground states of I^{125} and Te^{125} was found to be between 95 and 215 keV, with the most probable value 115 keV. The corresponding *ft* values for the transition to the 35·4 keV level of Te^{125} fall in the range of allowed transitions. A.

539.165

493. The estimation of the mean energy of a β-spectrum from the absorption curve. H. SCHOPPER. *Ark. Fys.*, **3**, 441–54 (*Paper* 23, 1951) *In German.*

The absorption of a β-activity in Al (with a standard geometry) is represented by the straight line $y = \text{const.}\ (E_m)^n$, where y is the intensity and E_m the max. energy of the electrons after passing through a certain absorber thickness; n is constant for any given absorption curve and depends on the max. energy (E_0) and the energy distribution. An empirical relation between n, E_0 and the mean energy $\bar{E}$ is exhibited graphically so that $\bar{E}$ can be obtained.

A. O. STANESBY

539.165

494. *j–j* coupling shell model and beta-decay. H. HORIE AND M. UMEZAWA. Letter in *Phys. Rev.*, **83**, 1253 (*Sept.* 15, 1951).

Estimating nuclear matrix elements for allowed β-transitions from a *j–j* coupling model in which charge multiplicity is a good quantum number, study of the spread of *ft* values for mirror and other nuclei suggest the β-interaction to be mainly Fermi type with Gamow–Teller interaction subsidiary.

R. H. DALITZ

539.165

495. β-ray spectrum and the *ft* value in the second transition. S. NAKAMURA, M. UMEZAWA AND H. TAKEBE. Letter in *Phys. Rev.*, **83**, 1273 (*Sept.* 15, 1951).

A reinterpretation of the forbidden β-spectra of Tc^{99} and Sb^{124} in terms of the second forbidden tensor interaction C_2T; *ft* values $\sim 10^{13}$ are obtained [see also Wu and Feldman, Abstr. 6428 (1951)].

A. O. STANESBY

539.165

496. Erratum: Spectrometer and coincidence studies on Np^{238}. M. S. FREEDMAN, A. H. JAFFEY AND F. WAGNER, JR. Letter in *Phys. Rev.*, **84**, 158 (*Oct.* 1, 1951). See Abstr. 8953 (1950).

539.165/.166

497. Beta-inner bremsstrahlung angular correlation. T. B. NOVEY. Letter in *Phys. Rev.*, **84**, 145 (*Oct.* 1, 1951).

This was measured in P^{32} using a stilbene crystal and photomultiplier tubes. There is excellent agreement with the theory reported in Abstr. 465 (1950).

W. J. SWIATECKI

539.165.2

498. Theory of beta-decay. T. H. R. SKYRME. *Progress in Nuclear Physics*, 1. *London, Butterworth Springer*; *New York, Academic Press* (1950) 115–39.

A review of developments since the publication of Konopinski's article [Abstr. 929 (1944)]. Attention is concentrated on those experiments which are significant for the general theory, but an attempt has been made to summarize or refer to most of the fruitful developments in theory both in general concepts and in analyses of particular problems which are amenable to experiment. Bibliography of 98 refs., mostly theoretical papers.

539.165.2

499. Mixed invariants in beta-decay and symmetries imposed on the interaction Hamiltonian. H. A. TOLHOEK AND S. R. DE GROOT. Letter in *Phys. Rev.*, **84**, 150 (*Oct.* 1, 1951).

The requirements of a symmetry between positron and negatron and particle and antiparticle imposes certain restrictions on the type (scalar, vector, etc.) of the interaction Hamiltonian. W. J. SWIATECKI

539.165.2

500. Experimental evidence for orbital electron emission accompanying beta-decay. J. A. BRUNER. *Phys. Rev.*, **84**, 282–8 (*Oct.* 15, 1951).

Experiments are described which indicate the existence of a mode of beta-disintegration in which the energy emitted is shared by three particles: beta-particle, neutrino and ejected orbital electron. The energy spectrum of the orbital electrons ("IB electrons") from Sc^{44} has been measured over the range 30 to 150 keV. The "IB internal conversion coefficient"—that is, the ratio of the measured number of IB electrons to the number of internal bremsstrahlung (IB) predicted by the theory of Knipp and Uhlenbeck, and Bloch—is found to be essentially constant over the measured energy range, and equal to 4·3. The frequency with which the three-particle disintegration takes place is about 0·04 times that of ordinary decay into a beta-particle and a neutrino. The measurements have an estimated accuracy of $+3\%$, -20%. A.

539.165.2

501. Angular correlation of the continuous radiation accompanying beta-decay. L. MADANSKY, F. LIPPS, P. BOLGIANO AND T. H. BERLIN. Letter in *Phys. Rev.*, **84**, 596 (*Nov.* 1, 1951).

Theoretical β–γ correlation functions are given, for allowed and first forbidden transitions. J. J. WILKINS

539.166

502. Gamma-rays from the deuteron bombardment of boron and the proton bombardment of aluminium. J. G. RUTHERGLEN, E. R. RAE AND R. D. SMITH. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 906–14 (*Oct.*, 1951).

The gamma-ray spectra from the nuclear reactions $B^{10} + d$, $B^{11} + d$ and $Al^{27} + p$ have been measured with a pair spectrometer. Lines are found from $B^{10} + d$ at $8{\cdot}88 \pm 0{\cdot}06$ MeV, $6{\cdot}7 \pm 0{\cdot}15$ MeV, $6{\cdot}4 \pm 0{\cdot}15$ MeV and $4{\cdot}38 \pm 0{\cdot}05$ MeV; from $B^{11} + d$ at $4{\cdot}44 \pm 0{\cdot}05$ MeV; and from $Al^{27} + p$ at $12{\cdot}12 \pm 0{\cdot}1$ MeV, $10{\cdot}46 \pm 0{\cdot}07$ MeV and $7{\cdot}62 \pm 0{\cdot}1$ MeV. The correlation of these gamma-rays with the energy levels of the nuclei involved is discussed. A.

539.166

503. Gamma-ray spectrum from the deuteron bombardment of C^{13}. L. M. BAGGETT AND S. J. BAME, JR. Letter in *Phys. Rev.*, **84**, 154 (*Oct.* 1, 1951).

Pair spectrometer measurements are reported. J. J. WILKINS

539.166

504. Gamma-ray spectrum and yield from tritium bombarded by protons. R. S. ROCHLIN. Letter in *Phys. Rev.*, **84**, 165 (*Oct.* 1, 1951).

Pair spectrometer measurements revealed a single gamma-ray line, corresponding to a Q value of $19{\cdot}7 \pm 0{\cdot}3$ MeV. J. J. WILKINS

539.166

505. The velocity of gamma-rays in air. M. R. CLELAND AND P. S. JASTRAM. *Phys. Rev.*, **84**, 271–3 (*Oct.* 15, 1951).

The velocity of 0·5 MeV gamma-rays resulting from positron annihilation has been measured by means of scintillation counters and delayed-coincidence techniques. The value obtained is $(2{\cdot}983 \pm 0{\cdot}015) \times 10^{10}$ cm/sec.

539.166

506. Internal pair conversion in Mg^{24} nuclei. M. R. CLELAND, J. TOWNSEND AND A. L. HUGHES. *Phys. Rev.*, **84**, 298–304 (*Oct.* 1, 1951).

A gamma-gamma coincidence counting method is used to detect pair emission from an excited state of Mg^{24}. The positrons are stopped in absorbing material surrounding the source and detected by their annihilation radiation. The coincidence rate due to annihilation radiation is distinguished from the rate due to cascaded nuclear gamma-rays by the sharp 180-degree angular correlation of the annihilation radiation. Pair emission from Mg^{24} is distinguished from gamma-ray pair production in the material surrounding the source by using materials of different atomic number Z. The efficiency of the apparatus for detecting positrons is determined by observing the coincidence rate from a Na^{22} source of known disintegration rate. This efficiency, combined with the fraction of the observed coincidence rate that is due to pair emission from Mg^{24} and with the known disintegration rate of the parent Na^{24} source yields a value of $(6{\cdot}7 \pm 1{\cdot}0) \times 10^{-4}$ for the internal pair-conversion coefficient of the 2·76 MeV transition in Mg^{24}. This value agrees with that calculated by Rose for electric quadrupole transitions of this energy. A.

539.166

507. Two-step isomeric transition in Ba^{133m} (39 hr). R. D. HILL, G. SCHARFF-GOLDHABER AND M. MCKEOWN. Letter in *Phys. Rev.*, **84**, 382–3 (*Oct.* 15, 1951).

Direct coincidence measurements show that the 275·5 keV, 39 hr γ-ray from Ba^{133m} is followed by a 11·7 keV, $< 5 \times 10^{-7}$ sec γ-ray, deduced to be $d_{3/2} \rightarrow s_{1/2}$ according to the shell model. The significance of this in connection with the expected rise of $s_{1/2}$ levels above $d_{3/2}$ levels in the region of the 5th neutron shell is illustrated. W. J. SWIATECKI

539.166

508. Angular correlation of the gamma-rays of Cs^{134}. B. L. ROBINSON AND L. MADANSKY. Letter in *Phys. Rev.*, **84**, 604 (*Nov.* 1, 1951).

First in a series of studies of correlations in cascade radiations using photomultipliers and "pulse-height" coincidence circuits. A 3-level scheme is deduced for Ba^{134}. W. J. SWIATECKI

539.166

509. Continuous γ-spectrum accompanying electron-capture. D. MAEDER AND P. PREISWERK. Letter in *Phys. Rev.*, **84**, 595 (*Nov.* 1, 1951).

The spectrum from Fe^{55} has been measured, using NaI scintillations, and gives good agreement with theory. J. J. WILKINS

539.166 : 539.152.2

510. The determination of the magnetic moment of an excited nuclear level (Cd^{111}, 247 keV). H. AEPPLI, H. ALBERS-SCHÖNBERG, A. S. BISHOP, H. FRAUENFELDER AND E. HEER. Letter in *Phys. Rev.*, **84**, 370–1 (*Oct.* 15, 1951).

There is excellent agreement with predictions of Abstr. 477 (1952) in the case of the observed decrease in the correlation in the γ–γ cascade in Cd^{111} with increasing magnetic field. The g-factor of the 247 keV level is deduced to be $-(0{\cdot}34 \pm 0{\cdot}09)$ and

its magnetic moment — (0·85 ± 0·22) confirming the $d_{5/2}$ assignment and (with other data) leading to spin assignments of $\frac{7}{2}$, $\frac{5}{2}$, $\frac{1}{2}$ for the 3 levels involved.
W. J. SWIATECKI

539.166.2 : 539.152.2 : 548.7

Anisotropy of gamma-radiation from oriented Co^{60} nuclei. *See Abstr.* 644

539.166.74

511. Detection of circularly polarized γ-rays and the production of polarized electrons. O. HALPERN. Letter in *Nature* [*Lond.*] **168,** 782 (*Nov.* 3, 1951).

See Abstr. 5787 (1951). Possible experiments are suggested. J. J. WILKINS

539.166.83

512. Theory of internal conversion. H. R. COISH. Letter in *Phys. Rev.*, **84,** 164 (*Oct.* 1, 1951).

A correction to the internal conversion coefficient is derived by calculating the electron emission rate to the same order in e^2 as was done for photon emission by N. Tralli and G. Goertzel [Abstr. 7250 (1951)]. W. J. SWIATECKI

539.166.835

513. Pair production by gamma rays in the field of an electron. V. VOTRUBA. *Bull. Int. Acad. Tchèque Sci.*, **49,** 19–49 (1948).

Calculates the differential cross-section, including recoil, retardation and exchange effects. The leading term of the total cross-section is obtained for very high energies (in asymptotic agreement with the indirect calculation of Wheeler and Lamb [*Phys. Rev.*, **55,** 858–62 (*May* 1, 1939)]) and for energies just above threshold [with discussion of the omissions responsible for Borsellino's result, Abstr. 2231 (1947)].
R. H. DALITZ

539.167.3

514. Carrier-free radioisotopes from cyclotron targets. XIX. Preparation and isolation of $Pt^{191, 193}$ from osmium. XX. Preparation and isolation of $Ru^{97, 103}$ from molybdenum. XXI. Preparation and isolation of $Tl^{200, 201, 202}$ from mercury. XXII. Preparation and isolation of Pb^{203} from thallium. XXIII. Preparation and isolation of $Rh^{100, 101, 102, 105}$ from ruthenium. J. D. GILE, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **19,** 1426–8 (*Nov.*, 1951).

For Pt XVIII, see Abstr. 8967 (1951).

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 378, 385–90

539.172

515. Meson-induced fission. S. GRAY AL-SALAM. *Phys. Rev.*, **84,** 254–8 (*Oct.* 15, 1951).

Several batches of plates loaded with uranyl acetate have been exposed to π^- mesons in the Berkeley cyclotron. The mesons were generated by the 350 MeV proton beam striking a C target and the plates were shielded from the direct beam, or positive particles generated at the target, by several inches of Cu. They received negative mesons over a wide range of energies. About one in a hundred of the mesons observed to end in these plates, ended in a characteristic fission event. Twenty-two such fissions were observed. This was in rough qualitative agreement with what might be expected if it is assumed that the capture of a negative π-meson by the U nucleus always produces fission. Three of these events showed 3-way fission, a light particle coming off at about 90° to the tracks of the heavy fission fragments. A.

539.172

516. A theoretical analysis of the process $\pi^+ + d \rightleftharpoons p + p$. G. F. CHEW, M. L. GOLDBERGER, J. M. STEINBERGER AND C. N. YANG. Letter in *Phys. Rev.*, **84,** 581 (*Nov.* 1, 1951).

A phenomenological discussion can explain the observed $\cos^2\theta$ angular distribution of the p's, but the observed increase in cross-section with energy is in disagreement with weak coupling meson theory, indicating that the meson wave function is strongly perturbed near the nucleon. [See also Abstr. 521 (1952)]. W. J. SWIATECKI

539.172.1

517. The mean square angle of emission of nucleons in high energy nucleon-nucleus collisions. H. MESSEL AND H. S. GREEN. Letter in *Phys. Rev.*, **83,** 1279 (*Sept.* 15, 1951).

This is calculated from the value obtained previously [Abstr. 8514 (1951)] for high energy nucleon-nucleon collisions. A graph is given, valid for nitrogen or oxygen nuclei. J. HUGHES

539.172.13

518. Further measurements of the angular distribution of α-particles from the $Li^7(p, \alpha)He^4$ reaction. F. HIRST AND R. UEBERGANG. *Aust. J. Sci. Res. A,* **4,** 284–95 (*Sept.*, 1951).

The distribution was measured for a proton energy range 0·3 to 0·9 MeV using scintillation counter technique. The angular distribution is well represented by the expression $Y(\theta) = Y(90°)[1 + A(E)\cos^2\theta + B(E)\cos^4\theta]$, where $A(E)$ and $B(E)$ are energy-dependent parameters denoting the departure from spherical symmetry and implying that p and f protons are important in the reaction. Curves of $A(E)$ and $B(E)$, of the theoretical form given by Inglis, have been fitted to the combined data of recent experiments analysed according to the above expression. A.

539.172.13

519. The excitation function for the production of ^7Be by the bombardment of ^{12}C by protons. J. M. DICKSON AND T. C. RANDLE. *Proc. Phys. Soc.* [*Lond.*] *A,* **64,** 902–5 (*Oct.*, 1951).

This has been determined by an activation method, using the internal proton beam of the 110 in Harwell cyclotron. The threshold energy has been found to be 32 MeV and the cross-section at 156 MeV is $11·0 \pm 1·3 \times 10^{-27}$ cm^2. A.

539.172.13

520. Some excitation functions for protons on magnesium. J. W. MEADOWS AND R. B. HOLT. Letter in *Phys. Rev.*, **83,** 1257 (*Sept.* 15, 1951).

Cross-sections for the $Mg^{25}(p, 2p2n)Na^{22}$, $Mg^{24}(p, 2pn)Na^{22}$ and $Mg^{26}(p, 2p3n)Na^{22}$ reaction obtained as functions of proton energy up to 100 MeV. W. J. SWIATECKI

539.172.13

521. Further evidence concerning the reaction $p + p \rightarrow d + \pi^+$. V. Peterson, E. Iloff and D. Sherman. Letter in *Phys. Rev.*, **84**, 372–3 (*Oct.* 15, 1951).

Energy spectra of π^+ from 340 MeV proton collisions at lab. angles of 18°, 30° and 64°. The peak at $63{\cdot}5 \pm 0{\cdot}3$ MeV meson energy gives $m_{\pi+} = 279{\cdot}0 \pm 1{\cdot}5\, m_e$. The integrated cross-sections indicate $\cos^2\theta$ angular dependence. [See also Abstr. 516 (1952)]. W. J. SWIATECKI

539.172.13

522. A high energy proton-proton collision with associated events. V. D. Hopper, S. Biswas and J. F. Darby. *Phys. Rev.*, **84**, 457–62 (*Nov.* 1, 1951).

An event observed in a nuclear emulsion is interpreted as an incident proton of energy 1 000 BeV colliding with a H nucleus and producing a cone of 6 charged mesons. The presence of 3 neutral mesons is deduced from two electron pairs and one triplet in the region of the cone. The triplet is due to an electron pair produced by a gamma-ray of energy 24 BeV in the field of an electron. An additional electron pair is produced by bremsstrahlung. The kinetic energies of several particles are deduced from scattering measurements and these range from 800 MeV to 17 BeV. The total energy of the shower is estimated as 100 BeV. In the centre-of-mass system the mesons have energies of the order of 400 MeV and an almost isotropic distribution. It is concluded that most of the energy is carried by two neutrons and only one-tenth of the energy of the primary particle goes to meson production. The results are compared with the theories of multiple meson production. A.

539.172.13

523. Excitation functions for deuterons and protons on Mg. F. O. Bartell and S. Softky. *Phys. Rev.*, **84**, 463–5 (*Nov.* 1, 1951).

Yields of F^{18}, Na^{22} and Na^{24} have been measured as a function of energy for both deuterons and protons on Mg. In some cases the yield of a single isotope can be attributed to a single nuclear reaction over a certain energy interval, this being done by a consideration of thresholds. These excitation curves are given over the ranges 0 to 20 MeV and 0 to 190 MeV for deuterons and from 0 to 31 MeV for protons. A.

539.172.13

524. Angular distribution of α-particles and protons from $Li^6 + D^2$. D. N. F. Dunbar and F. Hirst. *Aust. J. Sci. Res. A*, **4**, 268–83 (*Sept.*, 1951).

The distribution of α-particles for deuteron energies between 200 keV and 1 MeV may be represented by the expression $N(\theta) = N(90°)[1 + A(E)\cos^2\theta]$, where $A(E)$ is a function of deuteron energy. The variation of $A(E)$ with energy is due to the increasing penetration of the potential barrier by d deuterons. The angular distributions of the two groups of protons from $Li^6(d, p)Li^{7*}$, Li^7 have been investigated in the same energy range. The distributions are complex and require d deuterons for their complete specification in the form $N(\theta) = a_0P_0 + a_1P_1 + a_2P_2 + a_3P_3 + a_4P_4$, where P_n is the Legendre polynomial of order n. The results appear to resolve some differences apparent in earlier work. There is no evidence that the short range proton distribution is more complex than that of the long range group. A.

539.172.13

525. An investigation of the reaction $^9Be(d, p)$. A. J. Salmon. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 848–9 (*Sept.*, 1951).

The Q-values in the reactions $Be^9(d, p)Be^{10*}$ and $Be^9(d, p)Be^{10}$ were measured using photographic plates in conjunction with a magnetic spectrograph. An estimate of the differential cross-section at 90° for the former reaction was made at 301 and 440 keV, from a knowledge of the angle of acceptance of the spectrograph. J. HUGHES

539.172.13

526. Angular correlation in the reaction $^6Li(d,p)$-$Li^*(\gamma)^7Li$. J. O. Newton. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 938–9 (*Oct.*, 1951).

The measured p–γ angular correlation was found to be isotropic, which is interpreted as adding further weight to the suggestion that the spin of Li^{7*} is $\frac{1}{2}$. J. HUGHES

539.172.13

527. The long range tritons from the reaction $^9Be(d, t)^8Be$. F. A. El-Bedewi. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 947–8 (*Oct.*, 1951).

The Q-value of the reaction and the angular distribution of the tritons were measured at 7·70 MeV, using a photographic plate camera. The angular distribution shows a marked forward intensity maximum. J. HUGHES

539.172.13

528. (d, n) reactions with 15 MeV deuterons. II. Neutron energy spectra and yields. B. L. Cohen and C. E. Falk. *Phys. Rev.*, **84**, 173–8 (*Oct.* 15, 1951).

For Pt I, see Abstr. 8194 (1951). Energy spectra of neutrons produced by bombarding several thick targets with 15 MeV deuterons were measured at various angles by observing proton recoils in photographic plates and in a triple coincidence-anticoincidence proportional counter telescope. The spectra measured in or near the forward direction strongly indicate a stripping rather than a compound nucleus interaction, while for those measured at large angles the opposite is the case. Analyses of the shapes of the spectra at low energy, and a study of the yields as a function of atomic number indicate that the stripping process is one in which the penetration of a Coulomb barrier is important. This, together with an estimate of the relative cross-sections for stripping and compound nucleus formation, also seems to favour a stripping process in which the proton is captured by nuclear forces rather than one in which the deuteron is broken up by electric forces. A.

539.172.13

529. Bombardment of copper with tritons. D. N. Kundu and M. L. Pool. *Phys. Rev.*, **84**, 481–4 (*Nov.* 1, 1951).

Tritons have been accelerated to 6·5 MeV in a cyclotron and made to bombard stacks of Cu foils. Among the triton-induced reactions, the following have been identified: $Cu^{63}(t, d)Cu^{64}$ (12·9 hours), $Cu^{63}(t, n)Zn^{65}$ (250 days), $Cu^{65}(t, He^3)Ni^{65}$ (2·6 hours) and $Cu^{65}(t, p)Cu^{67}$ (2·44 days) with relative cross-sections for the various reactions as 11 : 64 : 6 : 10, respectively. The Oppenheimer–Phillips process

appears to be operative in case of tritons of this order of energy. A.

539.172.3

530. Threshold for the photoneutron reaction in Th^{232}. L. B. MAGNUSSON, J. R. HUIZENGA, P. R. FIELDS, M. H. STUDIER AND R. B. DUFFIELD. Letter in *Phys. Rev.*, **84**, 166 (*Oct.* 1, 1951).

The value $6{\cdot}35 \pm 0{\cdot}04$ MeV was obtained. J. J. WILKINS

539.172.3

531. *Z*-dependence of the cross section for photocapture by nuclei. J. HEIDMANN AND H. A. BETHE. *Phys. Rev.*, **84**, 274–81 (*Oct.* 15, 1951).

The number of neutrons evaporated by nuclei excited by Li(p, γ) photons is calculated along the compound nucleus formalism. It is found, for light nuclei, to be very small and to exhibit an odd-even alternation. From experimental cross-sections for photoneutron production at 17 MeV, the cross-section for photocapture by nuclei is deduced, and is found to be proportional to Z within 25%. Material is presented for the application of the compound nucleus formalism to light nuclei, in particular a formula for the density of levels. A.

539.172.3

532. Tantalum activities produced by photonuclear reactions on tungsten. A. J. MOSES AND D. S. MARTIN, JR. Letter in *Phys. Rev.*, **84**, 366 (*Oct.* 15, 1951).

539.172.3

533. Photoneutron thresholds. R. SHER, J. HALPERN AND A. K. MANN. *Phys. Rev.*, **84**, 387–94 (*Nov.* 1, 1951).

A 25 MeV betatron is used to measure the photoneutron thresholds of 77 isotopes by direct detection of neutron yields as a function of maximum bremsstrahlung energy. The neutrons, moderated in paraffin, are observed with a BF_3 proportional counter and time delay circuits. Threshold energies for 31 isotopes are repetitions of previously reported values from other laboratories and those for 46 isotopes are either new or more precise determinations. A.

539.172.3

534. Elastic scattering of photons by nuclei. J. S. LEVINGER. *Phys. Rev.*, **84**, 523–4 (*Nov.* 1, 1951).

The cross-section for nuclear resonance scattering is estimated for the case when the photon energy is far from resonance with the excitation energy for any level of the scattering nucleus. For photon energy much less than 15 MeV the cross-section is found to depend on the fourth power of the photon energy and is very much smaller than the nuclear Thomson cross-section for photon scattering by the nucleus as a whole. A.

539.172.3

535. Computation of photonuclear resonance curves from relative activity curves monitored by induced radioactivity. R. SAGANE. Letter in *Phys. Rev.*, **84**, 586 (*Nov.* 1, 1951).

539.172.3

536. Unusual broad resonances in $C^{12}(\gamma, n)C^{11}$ and $O^{16}(\gamma, n)O^{15}$. R. SAGANE. Letter in *Phys. Rev.*, **84**, 587 (*Nov.* 1, 1951).

539.172.3

537. Alpha-alpha correlations in the photodisintegration of C^{12} and the resonant absorption of electric radiation of non-e.d. character. V. L. TELEGDI. Letter in *Phys. Rev.*, **84**, 600 (*Nov.* 1, 1951).

Observed correlations are accounted for by assuming roughly equal magnetic dipole and electric quadrupole absorptions and spin $J = 2$ for the intermediate 3 MeV state of Be^8. J. J. WILKINS

539.172.3

538. Minimum gamma-gamma cross section in gold. A. G. W. CAMERON AND L. KATZ. Letter in *Phys. Rev.*, **84**, 608 (*Nov.* 1, 1951).

The cross-section curve for the reaction $Au^{197}(\gamma,\gamma)$-Au^{197m} (producing the 7·5 sec isomer) was found to have peak value 5 mb at 15 MeV, half-width 10 MeV. Theoretical estimates of further undetected (γ, γ) processes are made. J. J. WILKINS

539.172.4

539. Resonance in the neutron cross section of lithium. P. H. STELSON AND W. M. PRESTON. Letter in *Phys. Rev.*, **84**, 162 (*Oct.* 1, 1951).

A larger value has been obtained for the maximum cross-section at the large resonance at 270 MeV, which is now attributed to an excited state of Li^8 with $J = 3$ formed by $l = 2$ neutrons. [The diagram shown is incomplete.] G. J. KYNCH

539.172.4

540. The scattering of fast neutrons by bismuth and lead. C. E. MANDEVILLE AND C. P. SWANN. *Phys. Rev.*, **84**, 214–17 (*Oct.* 15, 1951).

Using good geometry, homogeneous fast neutrons of energy 4·3 MeV, supplied by the D–D reaction in the Bartol Van de Graaff statitron, have been scattered in bismuth and lead. Using binocular microscopes and Eastman NTA plates, fifty thousand fields of view were examined to obtain 5 000 acceptable recoil proton tracks. The energy spectrum of the scattered neutrons was studied to establish the presence or absence of any inelastic groups. From a consideration of gross effects, it is concluded that no inelastic group exists in the bismuth data with an intensity greater than 5% of the elastically scattered neutrons, or that no level in Bi^{209} lying between the ground state and 3·4 MeV is excited by a neutron group of more than 5% of the intensity of the elastic group. Appreciable inelastic scattering was noted in naturally occurring lead, the inelastic scattering cross-section being less than half the elastic cross-section. The energy distribution of the inelastically scattered neutrons is interpreted to indicate an energy level in lead in the vicinity of 3·3 MeV. This level is consistent with radioactivity measurements which show that most of the beta-disintegrations of $ThC'' \xrightarrow{\beta} {}^*Pb^{208}$ lead to energy levels in the vicinity of 3·2 MeV, and with Q-values of the reaction $Pb^{207}(d, p)Pb^{208}$ which disclose an energy level at 3·45 MeV in the nucleus Pb^{208}. A.

539.172.4

541. The inelastic scattering of fast neutrons in lead and bismuth. B. G. WHITMORE AND G. E. DENNIS. *Phys. Rev.*, **84**, 296–7 (*Oct.* 15, 1951).

The energy spectrum of 14 MeV neutrons from the $(T$–$D)$ reaction after transmission through 6 cm of

Pb or Bi, has been measured by the photographic emulsion method. Approximate agreement with the Weisskopf theory is found, the nuclear temperatures being 0·8 MeV for Pb, 0·9 MeV for Bi. In Pb there is some indication of a group with a discrete loss of energy of about 5 MeV. A.

539.172.4

542. Slow-neutron ternary fission of uranium 235. E. W. TITTERTON. *Nature* [*Lond.*] **168,** 590–1 (*Oct.* 6, 1951).

Experiments carried out at Harwell with uranyl acetate-saturated nuclear emulsions, irradiated in the two piles, are reviewed. More than 1 000 cases of ternary fission were observed during the examination of > a half million fission tracks. No protons or negative protons were observed, but α-particles with a most probable kinetic energy of 15 MeV and a maximum energy of 29 MeV were observed with a frequency of 1 event per 422 ± 50 binary fissions. The energy spectrum and angular distributions of these α-particles were consistent with their having been left at rest following fission and then accelerated in the field of the heavy fragments. No cases of Li^8, B^8 or Be^8 emission were observed, but there was some indication of emission of a third particle with $Z > 2$. No evidence for fission into three heavy particles was found. L. R. SHEPHERD

539.172.4

543. The thermal utilization factor in cylindrical symmetry. L. ORSONI. Letter in *Nuovo Cim.*, **8,** 434–5 (*June*, 1951) *In Italian.*

A formula is derived for the thermal utilization factor of a nuclear reactor with cylindrical uranium rods arranged in square or hexagonal pattern.

F. J. MIRANDA

539.172.4

544. The characteristic dimensions of the Châtillon pile. L. KOWARSKI. *J. Phys. Radium,* **12,** 751–5 (*July–Aug.–Sept.*, 1951) *In French.*

A description of the D_2O-moderated UO_2 pile. The heavy water is contained in a vertical Al cylinder 181 cm int. dia. × 235·5 cm high. The fuel elements, Al sheathed rods, 180 cm long × 66 mm int. dia., containing UO_2 packed to a density of 8·3 are arranged parallel to the axis of the cylinder in a hexagonal lattice of 18·6 cm pitch. The pile contains a maximum of 69 such rods containing *c.* 3·55 t of UO_2; it first became critical with 4·52 t of heavy water in the tank. Four shut-off rods are held out by electromagnets and fall in under gravity when released. Control is by 2 sheets of Cd, 60 cm × 30 cm, sliding vertically outside the tank, which is surrounded by a 90 cm graphite reflector. The maximum steady operating power is nearly 5 kW corresponding to a central thermal neutron flux of 2 or 3×10^{10} $n/cm^2/sec$, most of the heat produced being dissipated by natural convection to air in the gap between tank and graphite. Measurements indicate that the pile has a "Laplacian" of 6·5 m^{-2} to within 10%. L. R. SHEPHERD

539.172.4

545. Use of kilocurie radiation sources. B. MANOWITZ. *Nucleonics,* **9,** 10–13 (*Aug.*, 1951).

The production of 1 000–2 000 curie sources of Co^{60} and Ta^{182} in the Brookhaven reactor is described. These intense sources are being used to study the destruction of bacteria in foodstuffs, effects of γ-rays on chemical reactions and other possible industrial uses of strong radioactive sources. The ultimate purpose of this work is to find useful applications for the waste fission products from nuclear reactors.

L. R. SHEPHERD

539.172.4

546. Numerical computation of neutron distribution and critical size. A. S. THOMPSON. *J. Appl. Phys.*, **22,** 1223–35 (*Oct.*, 1951).

A numerical procedure is presented for the calculation, by diffusion theory, of the critical size of a nuclear reactor, and of the time-dependent distribution of neutrons in the reactor as a function of position (one-dimensional space) and neutron energy. The partial differential equations for diffusion theory are approximated by a system of ordinary differential equations, for which a stepwise convergent solution for neutron distribution is obtained. The critical size of the reactor is found from a comparison of the magnitude of the slowing down densities of the thermal and fission energy limits. The procedure is applied, by way of example, to a reflected sphere. This method for calculating neutron distribution is thought to be new in that an integration technique is developed and used for the solution instead of differentiation. Primarily because of this, the convergence to the correct solution is rapid. In a one-dimensional space all physical quantities can be considered as either continuous or discontinuous functions of both position and energy. Such items as fission and non-productive capture in the slowing down range can be included as part of a standardized procedure. Certain transient and steady-state perturbations, like motion of control rods, can be studied. A.

539.174

547. Production of high specific activities with a 22-MeV betatron. R. A. BECKER. *Rev. Sci. Instrum.*, **22,** 773–6 (*Oct.*, 1951).

An internal probe technique of producing strong gamma-*n* and gamma-*p* activities with a betatron is described. Sources approaching 1 millicurie in strength of Cu^{62} have been realized. A typical specific activity of Cu^{62} produced in a piece of half-mil copper 2 mm × 24 mm is 7 mc/g. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

548. Short μ-mesons tracks from π-meson decays. W. F. FRY. Letter in *Nuovo Cim.*, **8,** 590 (*Aug.*, 1951).

In 1 244 examples of μ-decay of artificially produced π-mesons, 7 events were found where the μ-tracks were unusually short. These are attributed to an alternative decay scheme of the π-meson.

E. P. GEORGE

539.18

549. Short μ-meson tracks from π-meson decays. W. F. FRY. Letter in *Phys. Rev.*, **83,** 1268 (*Sept.* 15, 1951).

Among 3 000 π–μ decay events from the Berkeley

cyclotron, four showed a μ range in emulsion of less than 300 microns. The grain count in the π-meson tracks is inconsistent with the energy necessary to explain the phenomena in terms of decay in flight, and the events are considered to show an alternative mode of π-decay. J. G. WILSON

539.18

550. Scattering of pi-mesons by the deuteron. J. S. BLAIR. Letter in *Phys. Rev.*, **83**, 1246 (*Sept.* 15, 1951).

Semi-quantitative account of "weak-coupling" calculations using scalar and pseudo-vector coupling. W. J. SWIATECKI

539.18

551. Charge exchange scattering of π-mesons in deuterium. B. SEGALL. Letter in *Phys. Rev.*, **83**, 1247 (*Sept.* 15, 1951).

Outline of a 2nd-order perturbation calculation of the cross-section with the most general type of coupling in the approximation in which the scattering amplitude of the deuteron is a linear superposition of single nucleon amplitudes. W. J. SWIATECKI

539.18

552. The τ-meson. P. E. HODGSON. Note in *Phil. Mag.*, **42**, 1060–1 (*Sept.*, 1951).

Gives details of the 3rd example observed at Imperial College, in nuclear emulsions exposed under ice. The frequency is higher than that under Pb, and a greater production in H than in other elements is suggested. E. P. GEORGE

539.18

553. On the nuclear scattering of negative pi-mesons. G. BERNARDINI, E. T. BOOTH AND L. LEDERMAN. Letter in *Phys. Rev.*, **83**, 1277 (*Sept.* 15, 1951).

Additional evidence from photographic plate measurements for the existence of (1) high probability of very large single scatterings, (2) inelastic scatterings with exceedingly large energy loss, makes it difficult to explain the scattering of mesons with any simple model based on known properties of meson-nucleon interactions. W. J. SWIATECKI

539.18

554. The interaction of π-mesons with nuclear matter. K. A. BRUECKNER, R. SERBER AND K. M. WATSON. *Phys. Rev.*, **84**, 258–65 (*Oct.* 15, 1951).

A number of experiments relating more or less directly to meson scattering and absorption are discussed and compared. Because of the variety of experiments interrelated by such considerations, it is seen that any model to describe meson scattering and absorption will have to meet a corresponding number of conditions. In particular, the absorption experiments of Panofsky and his collaborators permit one to put a lower limit on the absorption cross-section for complex nuclei which seems appreciably larger than the expected scattering cross-section. A.

539.18

555. On the nature of the *V*-particles. R. G. SACHS. *Phys. Rev.*, **84**, 305–8 (*Oct.*, 1951).

Disintegration of a neutral *V*-particle into a proton and negative meson strongly suggests that the *V*-particle is an excited state of the neutron. In order to account for the very long lifetime of this state, it is suggested that the nucleon has a very complex structure involving many mesons in virtual states. The excitation is then distributed over many degrees of freedom, so the probability for formation of that state which leads directly to disintegration may be very small. If n_0 is the average number of pions of each charge in the nucleon and f is the number of states available to a single pion, the lifetime for pion emission is estimated to be $t = fn_0^2 f \times 10^{-23}$ sec. For the reasonable choice $f = 10$ and $n_0 = 4$ this agrees with the observed lifetime of the neutral *V*-particle. A.

539.18

556. Polarization of vector mesons produced in nucleon-nucleon collisions. L. C. TENG. *Phys. Rev.*, **84**, 308–14 (*Oct.* 15, 1951).

The polarization of vector mesons produced in free nucleon-nucleon collisions near the threshold is studied. The calculation is made under the Born approximation, assuming a phenomenological nuclear potential obtained from *n–p* scattering data for the interaction between nucleons. The vector meson produced is shown to be completely polarized (to the order of m/M) parallel to the direction of motion of the incoming nucleon for vector coupling between meson and nucleon, and perpendicular to this direction for tensor coupling; similar to the polarization produced by the interaction between a nucleon and a nuclear force field, as studied by Wentzel. In particular, the same effect is shown to exist for the reactions $p + p \rightarrow p + n + \pi^+$ and $n + n \rightarrow p + n + \pi^-$ when the final proton and neutron fall into ^3s or ^1s deuteron states. The angular distribution of the out-going nucleons in the baricentric system for the inverse reactions can be employed as a means for detecting the polarization of the mesons. Cross-sections for these reactions are also estimated. A.

539.18

557. Evidence for the decay of a negative π-meson in a photographic emulsion. W. F. FRY. Letter in *Phys. Rev.*, **84**, 385–6 (*Oct.* 15, 1951).

In C2 emulsion exposed to Berkeley π-mesons, a π–μ decay event was observed in which the μ was 828 microns long. From its direction of motion, it is concluded that the π-meson is negative, and it is suggested that it decayed in flight when at an energy of order 50 keV. E. P. GEORGE

539.18

558. The absorption of pions by deuterons. R. DURBIN, H. LOAR AND J. STEINBERGER. Letter in *Phys. Rev.*, **84**, 581 (*Nov.* 1, 1951).

No large change in the angular distribution of the recoil protons in the meson energy range 25–53 MeV was observed, but the increase in total cross-section is steeper than that predicted even with pseudoscalar theory with pseudovector coupling. W. J. SWIATECKI

539.18

559. Capture and scattering of π^+ mesons. G. BERNARDINI AND F. LEVY. Letter in *Phys. Rev.*, **84**, 610 (*Nov.* 1, 1951).

Statistics of 150 nuclear interactions of 35–50 and 70–80 MeV π^+ mesons in Ilford 65 plates. Stars predominate as with π^+, but no "stops in flight,"

indicating that these are stars where a neutron is emitted. The large number of two fast-proton stars supports the two-nucleon model of Brueckner, Serber and Watson. W. J. SWIATECKI

539.18 : 539.166

560. On the question of meson formation. T. N. KHAZANOVICH. *Zh. Eksper. Teor. Fiz.*, **21**, 581–7 (*No.* 5, 1951) *In Russian.*

Calculates the cross-section for the production of scalar and pseudo-scalar neutral mesons by high-energy photons. The non-relativistic approximation only is considered. The production of charged mesons is discussed briefly. E. P. GEORGE

539.181

561. Phase shifts in the molecular beam method of separated oscillating fields. N. F. RAMSEY AND H. B. SILSBEE. *Phys. Rev.*, **84**, 506–7 (*Nov.* 1, 1951).

The effects of phase differences between the two oscillating fields in the separated oscillating fields method for molecular beam radiofrequency spectroscopy is discussed theoretically. It is shown that measurements in which the relative phase is changed from 0° to 180° effectively double the intensity of the signal and hence increase the sensitivity of the apparatus. Phase shifts of $\pi/2$ radians give resonances in the form of dispersion curves. Consequently, measurements in which the phase is changed from $+\delta$ to $-\delta$, where δ is near 90°, give particularly sensitive means of determining the resonance frequency. A.

539.185

562. Measurement of fast neutron velocities by delayed coincidence. D. B. JAMES AND P. B. TREACY. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 847–8 (*Sept.*, 1951).

The time of flight of a neutron to a distant detector is measured by delayed coincidence with the associated γ-ray detected near the target. Application to the $Be^9(d, n\gamma)B^{10}$ reaction gives a mean neutron energy of 2·5 MeV. W. J. SWIATECKI

539.185

563. Influence of a black sphere and of a black cylinder upon the neutron density in an infinite non-capturing medium. B. DAVISON. *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 881–902 (*Oct.*, 1951).

For a black body inserted into a homogeneous scattering medium, the neutron density at large distances from the body is determined using the perturbation method for the case when the scattering in the scattering medium is assumed elastic and isotropic capture is absent, and the following four types of the black body are considered: (i) a sphere of radius small compared with the mean free path in the scattering medium; (ii) a sphere of radius large compared with the mean free path; (iii) an infinitely long cylinder of radius small compared with the mean free path; (iv) an infinitely long cylinder of radius large compared with the mean free path. Combining the results for the above limiting cases with the results obtained by other methods the distribution is also estimated for a sphere and an infinitely long cylinder of intermediate radii. A.

539.185

564. Small angle scattering of 3·27 MeV neutrons by deuterons. I. HAMOUDA AND G. DE MONTMOLLIN. Letter in *Phys. Rev.*, **83**, 1277 (*Sept.* 15, 1951).

The angular distribution is presented graphically and includes an extension of earlier measurements [Abstr. 9000 (1951)] to include the angular range 18–70°. J. HUGHES

539.185

565. The scattering of 4·5- and 5·5-MeV neutrons by deuterons. E. WANTUCH. *Phys. Rev.*, **84**, 169–72 (*Oct.* 15, 1951).

By bombarding a thin deuterium gas target with deuterons 4·5 and 5·5 MeV neutrons were produced. Deuterons recoiling from neutron collisions in (*a*) a thin, heavy paraffin scatterer, and (*b*) a gas sample were detected by a double coincidence counter telescope. The angular distribution of recoiling deuterons, measured from 0° to 60° in the laboratory system, shows a sharp maximum for neutron scattering at 180° with a minimum at approximately 110° in the centre-of-mass system. The ratio of the differential cross-section at 180° to that at 110° is 5 : 1 for both energies. The experimental curves are compared with the theory of Buckingham and Massey. A.

539.185

566. Scattering of slow neutrons by H_2 and CH_4. A. M. L. MESSIAH. *Phys. Rev.*, **84**, 204–14 (*Oct.* 15, 1951).

The mass tensor approximation, introduced by previous authors to calculate the scattering cross-section of slow neutrons by molecules when the incident energy E_0 of the neutron is large compared with the average level spacing of the molecular rotations, is extended here to take into account the molecular vibrations. Calculations are made in the case of H_2 and CH_4 at room temperature for neutron energies below the threshold of excitation of higher vibrational states. The agreement with experiment is very satisfactory in the expected range of validity of this theory. The cross-section for higher E_0 is also treated in the case of H_2, without taking into account, however, the thermal agitation of the scattering molecules: the asymptotic form of the total cross-section for large values of E_0 is derived and numerical calculations show that the asymptotic behaviour is quickly reached. A.

539.185 : 519.2

567. Neutron age calculations in water, graphite and tissue. A. S. HOUSEHOLDER. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 6–8 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. A description, in general terms, of sampling procedures from which certain collision densities were estimated. N. L. JOHNSON

539.185 : 548.74

Use of single-crystal neutron diffraction data for crystal structure determination. *See Abstr.* 658

539.185.7 : 519.2

568. Report on a Monte Carlo calculation performed with the Eniac. M. MAYER. *Nat. Bur. Stand., Appl. Math. Ser., No.* 12, 19–20 (1951).

"Monte Carlo method" symposium paper [see

Abstr. 14 (1952)]. The absorption of neutrons in a composite cylindrical body was investigated.

N. L. JOHNSON

539.185.7 : 519.2

569. Calculation of shielding properties of water for high energy neutrons. P. C. HAMMER. *Nat. Bur. Stand., Appl. Math. Ser.*, *No.* 12, 21–3 (1951).

"Monte Carlo method" symposium paper [see Abstr. 14 (1952)]. A punched card system is used. It is arranged that after each "collision" a fresh card is punched to represent the new state of the neutron.

N. L. JOHNSON

STRUCTURE OF SOLIDS 539.2

539.215

570. Formation of annealing twins during grain growth. R. L. FULLMAN AND J. C. FISHER. *J. Appl. Phys.*, **22**, 1350–5 (*Nov.*, 1951).

It is proposed that annealing twins form during grain growth as a result of a decrease in the interfacial free energy of grain boundaries that would not be achieved in the absence of twinning. Experiments designed to permit detection of the changes in grain boundary free energy accompanying the formation of twins give results in agreement with this concept. The abundance of twins found in annealed copper depends on the texture in a manner that is consistent with the theory. A.

539.217

571. On the diffusion of Cd, Pb and Cu ions in crystals of silver bromide. E. SCHÖNE, O. STASIW AND J. TELTOW. *Z. phys. Chem.*, **197**, 145–60 (*June*, 1951) *In German.*

The dependence of the diffusion coefficient of Cd^{++}, Pb^{++} and Cu^{+} in AgBr crystals has been studied. It was found that in the first two cases only a fraction of the impurity ions associated with Ag^{+} vacancies contribute to diffusion. In the latter case three diffusion mechanisms appear to be possible.

P. T. LANDSBERG

539.217

572. Experimental evidence for the vacancy mechanism in diffusion in metals and alloys. F. C. NIX AND F. E. JAUMOT, JR. Letter in *Phys. Rev.*, **83**, 1275 (*Sept.* 15, 1951).

The diffusion coefficient of Co in CoAl alloys is a minimum at 50 at. % Al and shows a definite increase with increasing Al content above 50 at. %. This is attributed to the high vacancy concentration associated with the defective structure shown by such alloys at compositions above 50 at. %.

A. D. LE CLAIRE

539.217

573. Diffusion in grain boundaries and their structure. M. R. ACHTER AND R. SMOLUCHOWSKI. *J. Appl. Phys.*, **22**, 1260–4 (*Oct.*, 1951).

In order to gain an insight into the structure and properties of grain boundaries, diffusion along grain boundaries has been studied as a function of relative orientation of the grains and of the boundary. Experiments were made by comparing the depth of penetration of Ag along the boundaries of columnar Ag in the columnar direction [100]. The results indicate that, for angles of misfit between the grains greater than 20° and smaller than 70°, diffusion along grain boundaries is greater than volume diffusion (near 700°C) and reaches a maximum around 45°. Outside of that range of relative orientation the rate of grain boundary diffusion is not greater than volume diffusion. These results are correlated with the information available about the energy of grain boundaries, and it is concluded that at small angles the dislocation model of grain boundaries describes the situation satisfactorily, while at larger angles the grain boundaries are better described in terms of areas of fit and misfit. A.

539.217 : 539.163

574. Application of the radioactive tracer technique to the study of diffusion in solids. J.-C. HUTTER. *Bull. Soc. Chim. France*, **18**, 45D–52D (*July–Aug.*, 1951) *In French.*

After a general study of the principles of the use of radioactive tracers and of their particular application to the study of solid diffusion a brief survey of the theory of diffusion is given, followed by a rather fuller account of the theory and practice of various experimental methods for measuring diffusion coefficients by the use of radioactive tracers. In conclusion some of the results already obtained and some possible future lines of research are discussed. 94 references.

A. D. LE CLAIRE

539.23

575. On the deposition of protective films on glass surfaces. J. A. HEDVALL, R. JAGITSCH AND G. OLSON. *Z. phys. Chem.*, **196**, 23–34 (*Sept.*, 1950) *In German.*

Contains detailed discussions of the required treatment of the glass surface prior to the application of the film, the choice of varnish and the procedure when applying the film. P. T. LANDSBERG

539.26

576. Diffuse X-ray scattering by disordered binary alloys. II. W. J. TAYLOR. Letter in *Phys. Rev.*, **84**, 148 (*Oct.* 1, 1951).

An extension of the analysis in Pt I, Abstr. 5819 (1951). A. E. DE BARR

539.26/.27

577. Some observations on the clay minerals, kaolinite and halloysite, by the X-ray and electron microscopy. M. NAKAHIRA, S. IWAI AND A. SUZUKI. *J. Sci. Res. Inst.* [*Tokyo*] **45**, 52–6 (*July*, 1951).

X-ray diffraction photographs show that various degrees of stacking disorder exist in the clays examined. Particle shapes and sizes, obtained from electron micrographs, are given. A. R. STOKES

539.27

578. An approach to the microscopy of molecules. M. S. BLOIS, JR. *Science*, **114**, 175–7 (*Aug.* 17, 1951).

The molecular structure of substances such as collodion films is made visible under the electron microscope by evaporating on to the films metals which tend to migrate on the surface. The metal atoms on reaching the surface tend to agglomerate in

a pattern which outlines the molecular structure of the underlying film. Gold and silver are suitable metals. Several illustrations are given. J. IBALL

539.27

579 Electron diffraction by clay minerals with a fibrous or rod-like habit. D. R. KNAPP AND R. P. MITRA. Letter in *Nature* [*Lond.*] **168,** 380–1 (*Sept.* 1, 1951).

Clay particles deposited on a cellulose film are usually oriented with the basal (001) planes parallel to the film. Electron diffraction ring patterns of different clays are not easily distinguishable. Certain clays, however, such as halloysite, owing to a rod-like habit, give easily identifiable patterns. Other examples are given. M. R. HOPKINS

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31/.37 : 537.21

580. Distribution of dislocations in static equilibrium. G. LEIBFRIED. *Z. Phys.*, **130,** 214–26 (*No.* 2, 1951) *In German.*

Considers the problem of the distribution of dislocations under the influence of a strain field of force (and the analogous problem of the distribution of electrical line charges under the influence of an electric field). Various types of two-dimensional distributions are considered and the problem reduced to the solution of an integral equation of the form $\int_{-a}^{+a} \frac{D(x)dx}{x-\xi} = f(\xi)$, the general solution of which is known. E. P. WOHLFARTH

539.312

581. Free longitudinal vibrations of rubber and tissue strips. R. W. LAWTON AND A. L. KING. *J. Appl. Phys* **19,** 1340–3 (*Nov.*, 1951).

Frequencies of free longitudinal vibrations of several different specimens of rubber and aortic strips were measured as a function of applied load and relative length L/L_0, where L_0 is the initial length. Curves of $\omega^2 L_0/g$ versus L/L_0 have distinct minima that become sharper and move upward and toward the $\omega^2 L_0/g$ axis as the specimens become stiffer. The experimental curves are described rather well by theoretical equations derived from current relations for the extension of an ideal elastomer; they may be used for determining values of the elastomeric parameter β. The method is simple and rapid and is applicable to biological tissues as well as to other rubberlike substances. A.

539.319 : 535.55

Mechanical and optical properties of warm-stretched Plexiglass M.33 when tested in tension. *See Abstr.* 227

539.32

582. Experimental determination of the difference between the isothermal and adiabatic values of Young's modulus for aluminium. I. BARDUCCI. *Alluminio,* 416–18 (*No.* 5, 1950) *In Italian.*

Measurements were made of the log. decrement d_z of the flexural vibrations of an Al bar as a function of the frequency of vibration. The results fit quite closely the theoretical predictions of Zener, and from the value of the maximum which d_z shows at a particular frequency, the relative difference $\Delta E/E$ between the adiabatic and isothermal Young's moduli was calculated from the equation $\Delta E/E = 2d_z/\pi$. The result, $\Delta E/E = 4{\cdot}7\%$, is in fair agreement with that calculated from thermodynamic theory. The advantages and disadvantages of this indirect method of measuring $\Delta E/E$ are discussed. A. D. LE CLAIRE

539.32 : 548.0

583. Measurement of the elastic constants of silicon single crystals and their thermal coefficients. H. J. MCSKIMIN, W. L. BOND, E. BUEHLER AND G. K. TEAL. Letter in *Phys. Rev.*, **83,** 1080 (*Sept.* 1, 1951).

The elastic constants of two single crystals of Si were determined by measuring the velocities of propagation of both shear and longitudinal waves within the range 8–12 Mc/s. Agreement between the results was within 0·15%. The elastic constants at 25°C in dynes/cm² were: $C_{11} = 1{\cdot}6740 \times 10^{12}$, $C_{12} = 0{\cdot}6523 \times 10^{12}$ and $C_{44} = 0{\cdot}7957 \times 10^{12}$. The temperature coefficients of the elastic constants were also determined. A. C. WHIFFIN

539.373 : 548.0

584. The crystallographic aspect of slip in body-centered cubic single crystals. I. Theoretical considerations. A. J. OPINSKY AND R. SMOLUCHOWSKI. *J. Appl. Phys.*, **22,** 1380–4 (*Nov.*, 1951).

The mechanism of slip in body-centred cubic lattices is considered in terms of the relation between the orientation of the tensile axis and the active slip system. A "projection" of points in the unit stereographic triangle on its [001]–[011] side permits an analysis of experimental data and leads to an accurate determination of the ratio of the critical shear stresses on various planes. A.

539.373 : 548.7

The concept of force in dislocation theory. *See Abstr.* 645

539.374

585. The application of Nutting's equation to the viscoelastic behaviour of certain polymeric systems. R. BUCHDAHL AND L. E. NIELSEN. *J. Appl. Phys.*, **19,** 1344–9 (*Nov.*, 1951).

The Nutting equation $\varepsilon = \psi \times \sigma^{\beta} \times t^{n}$, where ε = strain, σ = stress, t = time, and ψ, β and n are material constants, is applicable to a large number of polymeric systems, such as plasticized polyvinyl chloride, styrene-butadiene copolymers, polystyrene. It has been shown that the material constant n is closely related to the damping coefficient as obtained from dynamic mechanical measurements. The temperature dependence of n and δ (damping coefficient) are about the same; and, in some cases, there exists a simple quantitative relationship between the two constants. A mathematical derivation of the relationship between n and δ is given and a physical interpretation of the dimensional changes in the Nutting equation, in terms of complex moduli, is presented. Furthermore it is shown that, in the case

of styrene-butadiene copolymer, n varies with the differences in gel content and gel structure. A.

539.374

586. The equilibrium of an elasto-plastic body. I. G. COLONNETTI. *C.R. Acad. Sci.* [*Paris*] **233,** 593–5 (*Sept.* 10, 1951) *In French.*

The expression for the time-dependent displacements is written down and a variational method is used to deduce the equilibrium condition.

J. E. CAFFYN

539.374

587. The equilibrium of an elasto-plastic body. II. G. COLONNETTI. *C.R. Acad. Sci.* [*Paris*] **233,** 644–6 (*Sept.* 17, 1951) *In French.*

A continuation of preceding Abstr. deducing the conditions for no change in external shape or dimensions of the body and the consequences of initial external forces acting on the body.

J. E. CAFFYN

539.374

588. The equilibrium of an elasto-plastic body. III–IV. G. COLONNETTI. *C.R. Acad. Sci.* [*Paris*] **233,** 677–8 (*Sept.* 24); 717–18 (*Oct.* 1, 1951) *In French.*

539.389.3

589. Mechanical ageing of hard drawn cut steel wires. F. SCHWIER. *F & G Rdsch., No.* 32, 215–28 (*July*, 1951) *In German.*

The influence of temperature and especially of time, on the mechanical ageing of cut and drawn steel wire is experimentally investigated. It is shown from temperature data that under normal conditions of drawing, rapid ageing of steel may occur. Previous work is referred to, wherein the importance of the tension-extension curve for different grades of steel wire is mentioned, and its dependence on the ageing processes. To avoid ageing phenomena in the drawing of steel wire, heat removal is all-important especially in multiple drawing machines. There are 12 references, 7 tables of data and 16 diagrams.

H. H. HODGSON

539.4 : 621–526 : 621.3.016.3

590. Design and analysis of a conservative dynamic load simulator. E. H. GAMBLE AND B. W. HATTEN. *J. Appl. Phys.*, **22,** 1250–7 (*Oct.*, 1951).

The design for a highly versatile dynamic load simulator is described, in which the correct resultant load is computed electrically and applied through a hydraulic servomechanism. One of the significant features of this machine is that virtually all of the power absorbed from the unit to which the load is applied is conserved in the form of electrical energy and returned to the power lines. A complete analysis of this electrohydraulic system is presented for the case in which Coulomb friction is negligible. Two basic applications for this simulator are a servo test stand designed primarily for testing autopilots and an aircraft control load simulator for both design and test of control systems. A.

539.4.01 : 532.696.1

Experimental researches on "wetting effect" and "liquostriction." *See Abstr.* 98

539.42 : 536.48

591. Fracture and yield stress of 1 020 steel at low temperatures. A. S. ELDIN AND S. C. COLLINS. Letter in *J. Appl. Phys.*, **22,** 1296–7 (*Oct.*, 1951).

Tensile tests were made on specimens at temperatures above 12°K. A sharp transition occurred near 61·5°K, below which no reduction of area occurred and above which the reduction of area increased rapidly with increase of the test temperature. The fracture stress, computed from the breaking load and the cross-section at the fracture, fell linearly with increase of temperature up to the transition point and then rose rapidly to a maximum at 100°K and fell again. The fractures appeared wholly brittle at temperatures below 100°K, but, with increase of test temperature above this value, there was an increase of a central zone of ductile material until at 185°K the fracture was characteristically ductile.

A. C. WHIFFIN

539.62

592. The nature of the static and kinetic coefficients of friction. E. RABINOWICZ. *J. Appl. Phys.*, **22,** 373–9 (*Nov.*, 1951).

Experiments have been carried out to determine the transition between static and kinetic conditions when stationary metal surfaces are set into motion, a simple method being used which measures the energy that has to be given to one of the bodies to start it moving. The method is confined to cases in which the static coefficient exceeds the kinetic. Using a load of 1 kg and metal surfaces of various kinds, it is found that the static coefficient persists for distances of the order of 10^{-4} cm, and then gradually falls off to values corresponding to the kinetic coefficient. This behaviour is shown to be consistent with a simple model based on the assumption that the friction force is needed to shear metallic junctions formed between the metal surfaces. The action of boundary lubricants is discussed and it is shown that they can act either by diminishing the metallic interaction directly, or by preventing its increase during the sliding process. A.

539.67

593. The role of tetragonal twins in the internal friction of copper manganese alloys. A. V. SIEFERT AND F. T. WORRELL. *J. Appl. Phys.*, **22,** 1257–9 (*Oct.*, 1951).

Internal friction studies have been made of an alloy 88% Mn–12% Cu. This alloy when annealed at 925°c and quenched to room temperature has a tetragonal structure of axial ratio 0·97. Twins are readily formed along the (101) and (011) planes. It has been suggested that relaxation across these twin boundaries would account for certain observed internal friction. Verification of this is shown. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.3 : 539.163

594. Solid phase determinations in the system aluminium sulphate/sulphuric acid/water using tracer technique. D. TAYLOR AND R. SCOTT. Letter in *Nature* [*Lond.*] **168,** 520 (*Sept.* 22, 1951).

By using radioactive Cs_2SO_4 as tracer, it has been possible to determine the composition of the solid phase in the above system; the result obtained has been confirmed when $MnSO_4$ was used as the tracer indicator. F. LACHMAN

541.124

595. The equilibrium hypothesis in chemical kinetics. I. PRIGOGINE. *J. Phys. Coll. Chem.*, **55,** 765–74 (*June*, 1951).

Paper presented before the Symposium on Anomalies in Reaction Kinetics (Section on the Activated Complex), held at the University of Minnesota, 1950. Contains a mathematical treatment, based on classical kinetic theory of gases, of non-equilibrium states. The starting-point is the Maxwell–Boltzmann equation and the assumptions made are (1) that particles with higher kinetic energy have an increased probability of inelastic collisions, and (2) that various species of particles have, in the moment of their creation by chemical reaction, energies that are different from the mean thermal energy. It has been found that the former effect is small but that the heat of reaction can perturb the Maxwell distribution to an appreciable extent. F. LACHMAN

541.124

596. Preparation and reactions of free vinyl radicals. A. W. TICKNER AND D. J. LE ROY. *J. Chem. Phys.*, **19,** 1247–9 (*Oct.*, 1951).

Ethylene, acetylene and butadiene are the predominant gaseous products of the reaction of Na vapour with vinyl iodide in the "diffusion flame." From the experimental evidence it is likely that these are formed by the disproportionation and recombination of vinyl radicals. In the presence of H, ethylene is also formed by the reaction $C_2H_3 + H_2 = C_2H_4 + H$. More vinyl iodide than Na is consumed in the reaction and a non-volatile organic iodide is formed. This has an important bearing on the calculation of the rate constant of the primary process. A.

541.124

597. Note on the temperature-independent factors of elementary reactions. E. W. R. STEACIE AND M. SZWARC. *J. Chem. Phys.*, **19,** 1309–10 (*Oct.*, 1951).

541.124 : 535.343–15

598. Study of chemical reactions by infra-red spectrography. G. GAUTHIER. *C.R. Acad. Sci.* [*Paris*] **233,** 617–19 (*Sept.* 10, 1951) *In French.*

Applications of the method are described to the hydrogenation of propiolic acid at normal temperatures in presence of a Raney Ni catalyst; and to the malate-fumarate isomerization in presence of a trace of I_2 (which attaches itself temporarily to the double bond and renders it potentially mobile). Malate concentration/time curves are plotted for 1–6% of I_2 at 15–170°C. J. GRANT

541.126

599. Why can a pressure pulse lead to ignition? W. JOST. *Z. phys. Chem.*, **196,** 102–5 (*Sept.*, 1950) *In German.*

The comparatively short times ($\sim 10^{-4}$ sec) (after the arrival of a pressure pulse) and low temperatures (~ 100°C) which appear to be required for the ignition of an explosive mixture are discussed qualitatively. It is pointed out that any theory must take into account the density fluctuations in the mixture, which may explain these results. P. T. LANDSBERG

541.127

600. On the speed of oxidation of zinc alloys. C. GENSCH AND K. KAUFFE. *Z. phys. Chem.*, **196,** 427–37 (*Feb.*, 1951) *In German.*

The rate of oxidation of Zn is increased by several orders of magnitude upon addition of a monovalent metal, but is decreased if a trivalent metal is added. This is attributed to an increased (or decreased, respectively) number of Zn ions in interstitial positions. P. T. LANDSBERG

541.127

601. Theory of the combustion of explosive powders. E. SÄNGER. *Z. phys. Chem.*, **197,** 265–76 (*Aug.*, 1951) *In German.*

The effect of pressure, storage and combustion temperatures, and of the water content, on the rate of combustion, have been investigated, together with related matters. P. T. LANDSBERG

541.127

602. On the detonation of secondary explosives by an electric spark and remarks on a note by James and Jacques Basset on the same subject. R. SCHALL. *C.R. Acad. Sci.* [*Paris*] **233,** 685–6 (*Sept.* 24, 1951) *In French.*

Replying to criticisms by MM. Basset [Abstr. 6526 (1951)], the author describes experiments demonstrating that pulverization of the tube containing the explosive is an unsatisfactory criterion of detonation. Black powder, which is incapable of detonation, pulverizes the containing tube when deflagration is initiated by a high-energy electric spark. Hexogene, initiated by the method of MM. Basset, would be judged to detonate on their criterion of tube-damage; but measurement by copper-crusher gauges of the peak pressure developed shows that detonation does not in fact occur under these conditions. It is suggested that the experimental technique of MM. Basset could be validated by substituting copper-crusher pressure-measurements for observation of tube-damage as the criterion of detonation. A. SCHOFIELD

541.127 : 537.312.5

603. Photoelectric observation of the rate of dissociation of N_2O_4 by a shock wave. T. CARRINGTON AND N. DAVIDSON. Letter in *J. Chem. Phys.*, **19,** 1313 (*Oct.*, 1951).

The technique makes use of the Schlieren effect. Differentiation between the physical events in a mixture of NO_2 and N_2O_4 is made possible by using radiation of two different wavelengths, 4 358 Å for NO_2 and 2 537 Å for N_2O_4 observations. W. SUMMER

ELECTROCHEMISTRY 541.13

541.135 : 621.357.7 : 620.197.5

604. The role of current distribution in cathodic protection. H. D. HOLLER. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 1–6 (*July*, 1951).

The paper outlines a procedure for determining current distribution over an electrode surface, as required in cathodic protection or in electroplating when the electrode potential bears a known relation to current density; and shows the relation of current distribution to resistance of current path and counter electromotive force. The primary current distribution (without polarization) is also computed. A method is suggested for determining the electrode-potential/current-density relation over an extensive surface in a uniform medium. In a non-uniform medium, the determination of current density by measurement of electrode potential becomes complex. In such a case the potential criterion of cathodic protection must be relied upon. A.

541.135.5

605. Measurement of the cathode current distribution in electrolytes. J. STEINER. *Z. phys. Chem.*, **196**, 235–57 (*Dec.*, 1950) *In German.*

541.135.5

606. Calculation of the constant of the hydrogen electrode. G. SUTRA. *C.R. Acad. Sci.* [*Paris*] **233**, 365–6 (*July* 30, 1951) *In French.*

Based on the principles of the author's new theory of hydrogen overvoltage [see Abstr. 9065 (1951)] the absolute potential of the normal hydrogen electrode is calculated to be 0·42 V, and that of the calomel electrode 0·70 V, at 25°. The activity of protons in a platinized plate is found to be $2{\cdot}3\times10^{7}$ (with Hg in 0·2N H_2SO_4), $2{\cdot}24\times10^{7}$ (with Pd in 0·2N H_2SO_4) and $2{\cdot}23\times10^{7}$ (with polished Pt in 0·2N H_2SO_4). H. H. HODGSON

541.135.5

607. Erratum: Fast electrode reactions. J. G. BARREDO. Letter in *J. Chem. Phys.*, **19**, 1429 (*Nov.*, 1951). See Abstr. 9066 (1951).

541.138

608. Potentials during the formation of membranes by precipitation. R. LANDSBERG. *Z. phys. Chem.*, **197**, 256–64 (*Aug.*, 1951) *In German.*

Curves of electrical potential as a function of time are given and discussed. It is suggested that there is a transport of ions through the membrane during its growth, but that the completed membrane is impermeable to anions. P. T. LANDSBERG

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

609. The stability of the photochemical reaction products in ionic crystals. H. PICK AND R. W. POHL. *Z. Naturforsch.*, **6a**, 360–3 (*July*, 1951) *In German.*

The suitability of AgBr as a basic photographic substance is reviewed in the light of a comparison of the elementary photographic processes with those of photochemical dissociation in alkali halides, and MgO. D. R. BARBER

541.14

610. The photolysis of acetic anhydride. R. J. KANDEL AND H. A. TAYLOR. *J. Chem. Phys.*, **19**, 1250–4 (*Oct.*, 1951).

The photolysis of acetic anhydride, probably by 1 849 Å radiation, has been studied in the temperature range 80° to 300°C at pressures of 10–60 mm dibutyl phthalate. From 80° to 224°C the rate is first-order during a run but the specific rate decreases with increasing pressure. The gaseous products are CO, CO_2 and C_2H_6 in approximately equivalent amounts. Biacetyl and methyl acetate have been identified among the liquid products. At 300°C the reaction is more complex, yields considerable amounts of H_2 and CH_4 and is not first-order. Comparison with formic acid photolysis leads to an approximate quantum yield of 2. A mechanism is suggested which accounts qualitatively for the observations. Deactivation of activated reactant molecules by acetic anhydride and by the gaseous products accounts for the low quantum yield. Added C_2H_6 and CO_2 are shown to increase the rate of photolysis, the more so the lower the pressure of acetic anhydride. Preliminary experiments have shown that the reaction can also be Hg-sensitized at a much faster rate of comparable temperatures but yielding the same products in similar amounts. A.

541.14

611. Direct observation of the rate of recombination of iodine atoms. N. DAVIDSON, R. MARSHALL, A. E. LARSH, JR AND T. CARRINGTON. Letter in *J. Chem. Phys.*, **19**, 1311 (*Oct.*, 1951).

A light pulse from a photo flash tube dissociates I_2 in presence of argon (M), and the reaction $I + I + M \rightarrow I_2 + M$, $d(I_2)/dt = k(I)^2(M)$, recorded on oscilloscope and k found. F. LLEWELLYN JONES

541.15

612. Effect of organic substances on the γ-ray oxidation of ferrous sulphate. H. A. DEWHURST. Letter in *J. Chem. Phys.*, **19**, 1329 (*Oct.*, 1951).

Aliphatic alcohols have a pronounced accelerating effect on the radiation-induced oxidation of ferrous sulphate, but the effect can be suppressed by adding sodium chloride. Sodium chloride has no effect in the absence of alcohols. Explanations in terms of free radicals are proposed. C. B. ALLSOPP

541.15

613. Measurement of the number of free radicals produced in organic liquids by the action of γ-rays. A. CHAPIRO. *C.R. Acad. Sci.* [*Paris*] **233**, 792–4 (*Oct.* 8, 1951) *In French.*

The number of free radicals produced by γ-rays in non-ethylenic compounds is measured by the disappearance of 1·1-diphenyl 2-picrylhydrazyl radical (DPPH) on the assumption that each radical formed reacts with 1 of DPPH. The results agree well with those previously obtained by the polymerization method [*J. Chim. Phys.*, **47**, 747, 764 (1950)]. C. B. ALLSOPP

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.183

614. Basic laws of adsorption (historical survey). E. CREMER. *Z. phys. Chem.*, **196**, 196–204 (*Sept.*, 1950) *In German.*

541.183

615. Adsorption of carbon dioxide on a nickel single crystal using a radioactive tracer. A. D. CROWELL AND H. E. FARNSWORTH. Letter in *J. Chem. Phys.* **19**, 1206–7 (*Sept.*, 1951).

By using C^{14} as a radioactive tracer the amounts of CO_2 chemisorbed on (1) polycrystalline Cu, Ni and Ag and (2) on the (111) face of a Ni single crystal, have been measured. Experimental details are given.

J. IBALL

541.183

616. Adsorption and hydrogenation of gases on transition metals. M. E. WINFIELD. *Aust. J. Sci. Res. A*, **4**, 385–405 (*Sept.*, 1951).

Several principles are suggested which determine the location, and to some extent the behaviour, of gas atoms chemisorbed at the surface of a transition metal. With these as basis, and the published experimental evidence, the structure of adsorbed oxygen, hydrogen, ethylene, acetylene, and carbon monoxide are deduced. For a diatomic molecule three kinds of chemisorbed product are distinguished—adsorbed molecule, adsorbed atom, and adsorbed ion. Bond energies, together with solid models of surface and adsorbate, are used to arrive at the probable mechanism of the ethylene hydrogenation on nickel, and of the Fischer–Tropsch hydrocarbon synthesis. A.

541.183

617. Effect of tension on water absorption by hair. L. R. G. TRELOAR. Letter in *Nature* [*Lond.*] **168**, 521–2 (*Sept.* 22, 1951).

The water absorption of horse hair was determined by direct weighing when the hair was under tension. It was found that the water content increases with stress. This result is contrary to that reported by White and Stam [*Text. Res. J.*, **19**, 136 (1949)], but is similar to the effect of swelling solvents on vulcanized rubber and is more in accordance with existing theories. J. IBALL

CHEMICAL STRUCTURE 541.2/.6

541.57 : 539.132

618. On the electron affinity of fluorine. R. H. JOHNSTON. *J. Chem. Phys.*, **19**, 1391–3 (*Nov.*, 1951).

The Hamiltonian for systems isoelectronic with neon is treated by perturbation methods. The energy of ionization of such systems is represented by a four-term expression (i.e. to third order of perturbation); the two leading terms are calculated, spectroscopic data for isoelectronic systems are used to evaluate the constants in the two remaining terms. The electron affinity of fluorine is estimated to be 73 ± 3 kcal/g atom. The corresponding dissociation energy of fluorine, as inferred by the Born–Haber cycle, is estimated to be 18 kcal/mole, to an accuracy believed better than $\pm$ 12 kcal/mole. A.

541.634

619. Rotational isomerism in hydrazine. E. L. WAGNER AND E. L. BULGOZDY. Letter in *J. Chem. Phys.*, **19**, 1210 (*Sept.*, 1951).

The infrared and Raman spectra of anhydrous hydrazine are used to distinguish between the possible models for the molecule, viz. the *cis*-model (C_{2v}), the *trans*-model (C_{2h}) and the gauche models (C_2). A C_2 configuration is indicated in liquid hydrazine at 60°C whilst in solid hydrazine at −190°C the molecules seem to be entirely in the *trans*-configuration.

W. R. ANGUS

541.64

620. Excluded volume effect in polymer chains. I. H. L. FRISCH, F. C. COLLINS AND B. FRIEDMAN. *J. Chem. Phys.*, **19**, 1402–9 (*Nov.*, 1951).

The number of allowed configurations of a polymer chain is considered on the basis of a random walk on an arbitrary "regular" lattice. Upper and lower bounds for the number of non-overlapping configurations in various lattices have been derived by means of a recursion formula method. The probability density function and its moments for the "head-to-tail" distance for short-range non-overlapping chains are shown to the calculable by the use of a generating function. The order of the logarithm of the number of non-superposable ring polymer chains has been shown to be directly proportional to the number of segments composing the ring.

LABORATORY APPARATUS 542.1/.7

542.2, 53.07

Further laboratory and workshop notes. *See Abstr.* 52

CHEMICAL ANALYSIS 543/545

545.373

621. Millicoulometry. II. The purported reduction of nitrate at the dropping mercury electrode. L. MEITES. *J. Amer. Chem. Soc.*, **73**, 4115–19 (*Sept.*, 1951).

For Pt I, see Abstr. 5895 (1951). The waves secured on adding nitrate to weakly acidic solutions of Li or Ce(III) chloride, which have in the past been attributed to reduction of the nitrate ion, are shown to be due to a catalytic reduction of water or hydrogen ion. A.

545.8

622. Determination of radium or radon in gases, liquids or solids. J. E. HUDGENS, R. O. BENZING, J. P. CALI, R. C. MEYER AND L. C. NELSON. *Nucleonics*, **9**, 14–21 (*Aug.*, 1951).

Nitrogen is bubbled through a solution containing a weighed amount of the test sample to remove all the radon. The nitrogen + radon is taken into an evacuated ionization chamber after passing through

a purifying system to remove water and acid vapours, oxygen and CO_2. Sufficient time is allowed to elapse for the growth of the radon disintegration products in the chamber, and the activity is then determined by counting α-pulses. Fabrication of the chamber from stainless steel, pure copper or other materials free from heavy metal impurities reduces background. Chambers previously filled with radon atmospheres are outgassed at 50°c and 10^{-4}–10^{-5} mm pressure. Precautions are taken to avoid spurious pulses in the counting circuits. A detection threshold of 10^{-20} g of radon (corresponding to 10^{-14} g of Ra in the dissolved sample) is claimed. The accuracy of the method has been established by measurements on standard Ra sources. L. R. SHEPHERD

545.82

623. On the criteria for pre-exposure of spectroscopic plates. M. GREEN; L. M. BRANSCOMB. Letters in *J. Opt. Soc. Amer.*, **41**, 862 (*Nov.*, 1951).

Trace spectrochemical analysis rarely needs pre-fogging of the plate as sufficient background is generally present. A correction is given to Branscomb's computations on maximum photosensitivity of the emulsion [Abstr. 4236 (1951)]; Branscomb admits the error in another letter. S. T. HENDERSON

545.82 : 771.534.53

624. A gamma-nomograph. E. S. HODGE. Letter in *J. Opt. Soc. Amer.*, **41**, 731–2 (*Oct.* 1951).

A small illustration of the nomograph is given. It allows the gamma of the emulsion to be found from the intensity ratio of two lines and their absorbance (or transmittance) values, provided that the latter are within the linear part of the characteristic curve. S. T. HENDERSON

545.844

625. Solid diffusion in chromatography. H. C. THOMAS. Letter in *J. Chem. Phys.*, **19**, 1213 (*Sept.*, 1951).

In chromatography on deep beds the effect of the finite rate of diffusion in the solid adsorbent or exchanger is studied theoretically. It is shown that in the case of an isotopic exchanger under slightly idealized conditions predictions can be made regarding the kinetic behaviour. J. IBALL

CRYSTALLOGRAPHY 548

548.0

626. Finite rotation groups and crystal classes in four dimensions. A. C. HURLEY. *Proc. Camb. Phil. Soc.*, **47**, 650–61 (*Pt* 4, 1951).

All finite rotation groups in [4] are constructed by a method due to Goursat, and the 225 (proper and improper) with integral trace selected. All but three of these are shown to be true crystal classes.

J. R. MADDOX

548.0 : 539.32

627. Third-order elastic coefficients of crystals. F. G. FUMI. Letter in *Phys. Rev.*, **83**, 1274 (*Sept.* 15, 1951).

The independent non-zero 3rd-order elastic coefficients of crystals $C_{pqr} = C_{prq} = C_{qpr}$ ($p.q.r. = 1, 2, 3, 4, 5, 6$) (6th-order polar tensor) have previously been known only for cubic groups and for C_3. They are here derived for all the crystal classes in which orthogonal Cartesian co-ordinates can be found that do not transform into linear combinations of themselves under the symmetry operations of the crystal, and for certain other cases. A. J. KENNEDY

548.0 : 539.373

The crystallographic aspect of slip in body-centered cubic single crystals. I. Theoretical considerations. *See Abstr.* 584

548.24

628. Twinning and slip in α-uranium. R. W. CAHN. Note in *Acta Cryst.*, **4**, 470–1 (*Sept.*, 1951).

Four distinct families of twins were observed, and these are defined. In two of these generation of the twin orientation is not exactly possible by pure shear. Slip is predominately in the [100] direction on the (010) plane with cross-slip on (011) and (013).

A. J. KENNEDY

548.5

629. Growth forms of tungsten [crystals] and the equilibrium shape of body-centred cubic crystals. B. HONIGMANN, E. W. MÜLLER AND I. N. STRANSKI. *Z. phys. Chem.*, **196**, 6–11 (*Sept.*, 1950) *In German*

A study of the growth forms of W, Mo and Ta single-crystal cathodes with the aid of the electron microscope. P. T. LANDSBERG

548.5

630. On the orientations of zinc crystals produced by the Bridgman method. L. M. SLIFKIN. Letter in *J. Appl. Phys.*, **22**, 1216 (*Sept.*, 1951).

The basal planes of crystals of high purity Zn grown in glass cylinders, were usually oriented approx. parallel to the surface on which growth commenced. Compare *Z. Krist.*, **85**, 322–5 (*April*, 1933). J. A. FRANKS

548.5

631. Homogeneous extension of single crystals. F. D. ROSI. Note in *Rev. Sci. Instrum.*, **22**, 708–10 (*Sept.*, 1951).

The distortion arising from the constraints imposed by the grips may be reduced by the use of gimbals.

A. J. KENNEDY

548.5

632. The theory of oriented overgrowth of crystals. F. C. FRANK; M. BLACKMAN. Letters in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 941–3 (*Oct.*, 1951).

A reply to Smollett and Blackman's paper [Abstr. 8340 (1951)] on stability of a monolayer of an alkali halide on the surface of another alkali halide, with a further comment by Blackman. J. A. FRANKS

548.5

633. The structure of thin layers of zinc oxide grown on a zinc single crystal. L. N. D. LUCAS. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 943–5 (*Oct.*, 1951).

Electron diffraction photographs of a thin layer

of ZnO grown on a Zn cleavage plane show no evidence of a pseudomorphic layer. J. A. FRANKS

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

634. The thermal stability of *F*-centers in alkali halides. A. B. SCOTT AND W. A. SMITH. *Phys. Rev.*, **83**, 982–6 (*Sept.* 1, 1951).

The *R'*-band reported previously [Abstr. 8624, 8869 (1950)] in additively coloured KCl has been found to contain a distinct band which, above a certain total colour-centre concentration, is in heterogeneous thermal equilibrium with the *F*-centres. The variation of the saturation concentration of *F*-centres with temperature has been studied and a latent heat for the dissociation of the coagulated centres has been determined. A.

548.7

635. The Coulomb energy of complex crystals. E. FISHER. *J. Chem. Phys.*, **19**, 1284–5 (*Oct.*, 1951).

A method of computing Madelung constants is adapted to the problem of determining the electrostatic energy of complex ionic crystals. A.

548.7

636. Note on superlattices and Brillouin zones. J. C. SLATER. *Phys. Rev.*, **84**, 179–81 (*Oct.* 15, 1951).

In a number of alloys, such as CuPt, an ordered phase is formed below a definite temperature, in which atoms of the two sorts are localized in alternate layers. In some cases in the ordered phase an atom of each sort is surrounded by equal numbers of atoms of both sorts, so that the ordinary explanation of ordering, the preference of an atom to be surrounded by neighbours of the opposite type, does not apply. It is pointed out, however, that in such a case the Brillouin zone is split by the double periodicity in the lattice, with modification of the energy levels such that if the zone is approximately half-filled with electrons, the electronic energy is decreased by an amount proportional to the square of the degree of order. It is suggested that this decrease of energy is what stabilizes the ordered phase. It is also suggested that in some metals, a similar effect on the Brillouin zones would occur if alternate layers were slightly displaced in opposite directions along the normal to the planes. This also might stabilize such a structure, at low temperatures, leading to a narrow energy gap above the occupied levels, with consequent increase of resistance; this might explain the resistance increase of Mg and Au at low temperatures. The similarity of these effects to current theories of antiferromagnetism and of superconductivity is pointed out.

A.

548.7

637. Statistical theory of properties of solid solutions. R. SMOLUCHOWSKI. *Phys. Rev.*, **84**, 511–18 (*Nov.* 1, 1951).

Properties of binary solid solutions are considered from the point of view of the fluctuation of local composition in the crystalline lattice. These variations influence the properties of the alloys by varying the corresponding local concentration of electrons. A simple general statistical method is given for calculating properties of random and ordered solid solutions. The theory is applied to saturation magnetization, temperature coefficient of electrical resistivity, thermoelectric power, and to other properties in various alloys. A satisfactory agreement with experiment is obtained. A.

548.7

638. I. Normal frequencies of a one-dimensional crystal. II. An approximation to the lattice frequency distribution in isotropic solids. J. O. HALFORD. *J. Chem. Phys.*, **19**, 1375–9 (*Nov.*, 1951).

I. The accurate expression for the individual frequencies of a linear crystal of any number of particles is derived.

II. It is shown that, for an isotropic three-dimensional array of uniform masses, the root-mean-square frequency is easily evaluated and the maximum square must always be less, but not much less, than twice the mean square. For two commonly studied simple cubic systems, the maximum square is evaluated and shown to be twice the mean square. The Debye expression for the frequencies in terms of standing wave components is modified empirically to give the correct maximum and mean squares by substituting linear crystal frequencies for the components and introducing a second force constant. The resulting expression, a simplified form of the factored secular equation, should yield a more realistic and probably therefore a more widely useful distribution function than the Debye equation. A.

548.7

639. On the structure of gas hydrates. M. v. STACKELBERG AND H. R. MÜLLER. Letter in *J. Chem. Phys.*, **19**, 1319–20 (*Oct.*, 1951).

Gas hydrates exist in 2 distinct cubic structures, viz. 48 and 136 H_2O mols per unit cell, cell const. 12 and 17·2 Å, and space group O_h^3–*Pm3n* and O_h^7–*Fd3m*, respectively. Claussen's conclusions [Abstr. 5907 (1951)] are confirmed. J. GRANT

548.7 : 536.424.1

640. The theory of rotational phase transition in anisotropic molecular crystal. T. OGUCHI. Letter in *J. Chem. Phys.*, **19**, 1321–2 (*Oct.*, 1951).

Nearest neighbour interactions on a simple cubic lattice are considered. The energies are taken to be equal in the x and y directions but differing in magnitude and sign in the z direction. The configurational partition function is investigated by Kikuchi's method —corresponding to Bethe's first approximation [see Abstr. 5134 (1951)]. Expressions are given for the transition temperature and the specific heat discontinuity. R. O. DAVIES

548.7 : 536.631

641. External oscillations and specific heat of calcite. L. GIULOTTO AND A. LOINGER. Letter in *J. Chem. Phys.*, **19**, 1316–17 (*Oct.*, 1951).

A calculation of the normal external frequencies of calcite, based partly on the solution of the equations of motion of a CO_3 ion and partly on experimental results (Raman spectrum), is used to calculate the temperature variation of C_v, using Einstein functions

for the optical frequencies and Debye functions for the acoustical frequencies. Comparison with experiment is difficult above 150°K since the dilatation correction cannot be estimated. E. P. WOHLFARTH

548.7 : 537.226.2

642. Local fields in ionic crystals. M. H. COHEN. Letter in *Phys. Rev.*, **84**, 368–9 (*Oct.* 15, 1951).

A method of calculating local fields at the actual positions of displaced atoms in a crystal lattice is discussed. A. L. MACKAY

548.7 : 537.226.2

643. Ferroelectricity *versus* antiferroelectricity in barium titanate. M. H. COHEN. Letter in *Phys. Rev.*, **84**, 369 (*Oct.* 15, 1951).

Consideration of dipole-dipole interactions of O and Ti ions lying in lines parallel to the spontaneous polarization does not explain why $BaTiO_3$ is ferroelectric and not antiferroelectric even if local fields at the actual lattice points are used (see preceding Abstr.). A. L. MACKAY

548.7 : 539.166.2 : 539.152.2

644. An experiment on nuclear alignment: the anisotropy of γ-radiation from oriented cobalt-60 nuclei. J. M. DANIELS, M. A. GRACE AND F. N. H. ROBINSON. Letter in *Nature* [*Lond.*] **168**, 780–1 (*Nov.* 3, 1951).

Crystals containing Co^{60} were cooled to 0·02°K and considerable (44%) anisotropy was observed. J. J. WILKINS

548.7 : 539.373

645. The concept of force in dislocation theory. M. O. PEACH. *J. Appl. Phys.*, **22**, 1359–64 (*Nov.*, 1951).

The concept of "force acting on a dislocation" (or other imperfection) is intrinsically different from the concept of force as used in Newtonian mechanics, and must be defined. A definition is given which preserves the basic property (1) that the direction of the resultant force gives the direction in which the imperfection will actually move if the atomic constraints do not prevent motion. For imperfections in an infinite crystal, and assuming linear elasticity, two further properties are established: (2) the parallelogram law of adding forces is valid, and (3) Newton's law of equal and opposite action and reaction is valid. A critical review of previous work relating to forces between crystal imperfections is given. A.

548.73 : 535.24

646. An integrating-photometer method for the determination of intensities of X-ray reflections. O. HAUSER. *Technik*, **6**, 415–19 (*Sept.*, 1951) *In German.*

The method is similar to that of Dawton [*Proc. Phys. Soc., Lond.*, **50**, 919 (1938)]. A positive print is taken and the amount of light transmitted by each white diffraction spot is measured. The conditions for linearity of response are investigated and the photometer is described in detail. A. R. STOKES

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 576–9

548.732 : 537.531 : 535.42

647. Photon-phonon interaction and the scattering of X-rays in aluminium. P. OLMER. *Bull. Soc. Franç. Minér. Crist.*, **71**, 145–258 (*April–June*, 1948) *In French.*

A much more detailed account of work already abstracted [Abstr. 2755 (1948), 5789 (1949)] from shorter publications. A. J. C. WILSON

548.734.4

648. Crystal orientation on the Weissenberg goniometer. B. JERSLEV. Note in *Acta Cryst.*, **4**, 472–3 (*Sept.*, 1951).

A modification of Bunn's method [*Chemical Crystallography*, Oxford, Clarendon Press (1945)], depending upon curvature of the zero layer-line when the crystal is mis-set. A. R. STOKES

548.734.5

649. Note on Stadler's double-slit Weissenberg technique. W. R. RUSTON. Note in *Acta Cryst.*, **4**, 473 (*Sept.*, 1951).

By means of a simple modification, the Unicam double-crystal Weissenberg goniometer may be used for Stadler's technique [Abstr. 6164 (1950)]. A. R. STOKES

548.735

650. X-ray asterisms from deformed crystals. P. GAY AND R. W. K. HONEYCOMBE. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 844–5 (*Sept.*, 1951).

X-ray microbeam diffraction photographs of deformed aluminium show that kink bands (regions of lattice curvature) are responsible for asterisms in Laue photographs. A. R. STOKES

548.736.1

651. Anomalous X-ray diffraction spectra in graphite. J. S. LUKESH. Letter in *J. Chem. Phys.*, **19**, 1203–4 (*Sept.*, 1951).

"Extra" diffraction lines from graphite, some of them identical with those from natural graphite, were produced in purified graphite by electrolysis in KBr solution, the graphite being the anode. This suggests that the normal structure may be modified by impurities. A. R. STOKES

548.736.4

652. The crystal structure of $CsSb_2F_7$. A. BYSTRÖM AND K.-A. WILHELMI. *Ark. Kemi*, **3**, 373–80 (*Paper* 40, 1951).

Monoclinic, $C2/c$, $a = 19·32$, $b = 6·89$, $c = 5·58$ Å, $\beta = 90°$, measured density = 4·54, $Z = 4$, calculated density 4·55, 4Cs in (e) with $y = 0·230 \pm 3$, 8Sb in (f) with $x = 0·1694 \pm 15$, $y = -0·239 \pm 3$, $z = 0·283 \pm 3$, 4F in (d), $3\times$8F in $3\times$(f) with $x, y, z =$ ($0·070 \pm 1$, $0·583 \pm 3$, $0·167 \pm 3$), ($0·105$, $0·00$, $0·333$), ($0·167$, $0·292$, $0·139$) respectively. Rotation and Weissenberg photographs with CuK and powder photographs with CrK were used, and the parameters found by trial and error. A. J. C. WILSON

548.736.4

653. The crystal structure of potassium hexafluoroplatinate (IV). D. P. MELLOR AND N. C. STEPHENSON. *Aust. J. Sci. Res. A*, **4**, 406–11 (*Sept.*, 1951).

The structure is based on a hexagonal unit cell whose dimensions are $a = 5·76$, $c = 4·64$ Å. There is one molecule per cell and the space group is $D_{3d}^3 - C\bar{3}m$. The Pt–F distance in the slightly irregular octahedral fluoro complex is 1·91 Å. A.

548.736.4

654. The nature of the second-order transition in ND_4Br. H. A. LEVY AND S. W. PETERSON. Letter in *Phys. Rev.*, **83**, 1270 (*Sept.* 15, 1951).

A complete crystal structure determination of the

low and room temperature phase suggests that the 2nd-order phase transition marks the onset of orientational disorder. J. JACOBS

548.736.5

655. The positions of the barium atoms in hollandite. A. BYSTRÖM AND A. M. BYSTRÖM. Note in *Acta Cryst.*, **4**, 469 (*Sept.*, 1951).

A modification of the authors' structure [Abstr. 3542 (1950)] is suggested. It has two-dimensional disorder. A. R. STOKES

548.737

656. The crystal structures of some α-amino acids. A preliminary X-ray examination. B. DAWSON AND A. McL. MATHIESON. Note in *Acta Cryst.*, **4**, 475–7 (*Sept.*, 1951).

The unit-cell dimensions, densities, numbers of molecules per unit cell and space groups are given, for 9 aliphatic, 4 carboxylic and 2 heterocyclic compounds. A. R. STOKES

548.737

657. Electron diffraction results and the structure of the carboxyl group. M. DAVIES AND W. J. O. THOMAS. Letter in *Research* [*Lond.*] **10**, 384–5 (*Aug.*, 1951).

The results of several authors are discussed in relation to X-ray diffraction measurements and infra-red absorption spectra. A. R. STOKES

548.74 : 539.185

658. The use of single-crystal neutron diffraction data for crystal structure determination. S. W. PETERSON AND H. A. LEVY. *J. Chem. Phys.*, **19**, 1416–18 (*Nov.*, 1951).

Intensities of neutron reflections from single-crystal specimens of several substances have yielded structure factors in close agreement with calculation and with those measured by the usual powder method. Specimens whose dimensions were in the millimetre range were used. Three materials yielded low results, probably because of extinction in the single-crystal specimens. The use of single-crystal neutron reflections for crystal structure determination appears practical in many cases. A.

GEOPHYSICS 55

ATMOSPHERE . METEOROLOGY 551.5

551.508.71

659. A new development in the measurement of high relative humidities. W. R. STEIGER. *Science*, **114**, 152–3 (*Aug.* 10, 1951).

Describes the construction, operation and calibration of an electric hygrometer by means of which it is possible to measure high relative humidities (80–100%) in remote and confined spaces. The relative humidity is measured as a function of the electrical conductivity of a hydrophilic chemical (combination of LiCl and polyvinyl alcohol). The functional relationship between the resistance of a platinum wire resistance coated with this chemical may be represented for the range 80–95% r.h. by $\log r = mH + \text{const.}$, where r is the resistance and H the relative humidity. From 95% to 100% r.h. the sensitivity increases *c.* twofold. The method is suitable for the indirect measurement of the free energy of soil moisture through the meas. of the equilibrium r.h. of the enclosed atmosphere. F. LACHMAN

551.510.4

660. Erratum: A self-consistent treatment of the oxygen dissociation region in the upper atmosphere. H. E. MOSES AND T.-Y. WU. Letter in *Phys. Rev.*, **84**, 168 (*Oct.* 1, 1951). See Abstr. 7404 (1951).

551.510.535

661. The determination of the collisional frequencies in regions E and F of the ionosphere. K. RAWER, K. BIBL AND E. ARGENCE. *C.R. Acad. Sci.* [*Paris*] **233**, 667–9 (*Sept.* 17, 1951) *In French.*

Measurements of the ionospheric absorption of radio waves are used to estimate the collisional frequencies in regions E and F. The results are briefly considered in relation to layer curvature and to the critical collisional frequency condition required for the observation of the third component. W. J. G. BEYNON

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 423–6

551.513

662. A survey of the stress between the ocean and atmosphere. C. H. B. PRIESTLEY. *Aust. J. Sci. Res. A*, **4**, 315–28 (*Sept.*, 1951).

A survey is made of the mean east-west component of stress between the ocean and atmosphere for each season and each ocean, and for the mean of all oceans. The averaging is carried out for each 5° latitude zone from 55°N to 55°S. The results provide a first approximation to the total torque about the Earth's axis, on the atmosphere as a whole, in the various latitude belts. From them is derived a table showing the distribution of total northward flux of atmospheric angular momentum for the annual mean and the four seasons individually, allowing for the changes occurring during spring and autumn. A brief comparative discussion of both the stress and flux results is given. A.

551.515.7

663. The structure of steady-state anticyclones. R. W. JAMES. *Aust. J. Sci. Res. A*, **4**, 329–43 (*Sept.*, 1951).

It is found that symmetrical anticyclones of the Australian region exhibit roughly similar pressure profiles. The total pressure rise within a high is approximately proportional to the area covered by the disturbance, large systems in higher latitudes being more intense than small systems in lower latitudes. These structural properties are shown to be a consequence of the requirement for gradient-wind balance within an anticyclone, which requirement

is shown to limit the intensity of a high of specified size. The theory indicates that the variation of the size of anticyclones should be restricted, and that disturbances in higher latitudes should have higher mean intensities. Both these requirements are borne out by observation. A.

551.593.1 : 612.84 : 525.722

664. The scintillation of starlight. A. H. MIKESELL, A. A. HOAG AND J. S. HALL. *J. Opt. Soc. Amer.*, **41**, 689–95 (*Oct.*, 1951).

This study consists of the quantitative observation of the distribution of harmonic component of scintillation with frequency. Examples of preliminary results at frequencies ranging from 10 to 800 c/s are used to exhibit changes in this frequency distribution with visual seeing, zenith distance of the observed object, altitude above sea level, size of circular aperture and orientation of rectangular aperture. Motion pictures of shadows on a 40 in mirror caused by atmospheric disturbances which produce scintillation indicate that these shadows have a transitory nature. Motion pictures of Hartmann images demonstrate changes of size, shape and brightness (scintillation) of stellar images formed as light from the same star passes through four widely-separated apertures in front of the 40 in mirror. Colour scintillation is demonstrated with tracings from a dual-beam oscillograph. Other tracings show that scintillating starlight is not polarized. A.

551.593.9 : 535.332

665. The forbidden ^4S–^2D line of neutral N in the spectra of twilight and the night sky. M. DUFAY. *C.R. Acad. Sci.* [*Paris*] **233**, 419–21 (*July* 30, 1951) *In French.*

Spectrograms taken during period, twilight→night, in summer show the forbidden N line at 5 199 Å consistently, although it is absent from long-exposure plates obtained under similar conditions in winter. Line excitation at 5 199 Å, and also at 10 406 Å, is attributed to absorption of solar u.v. radiation at 3 466 Å. D. R. BARBER

551.594 : 539.16.08

666. Research into the radioactivity of free air. H. GARRIGUE. *C.R. Acad. Sci.* [*Paris*] **233**, 860–2 (*Oct.* 15, 1951) *In French.*

See also Abstr. 7215 (1949), 5941–3 (1951). Reports further measurements of the radioactivity of air on the ground (1 460 m above sea level) and at 3–6 000 m: further evidence of the radioactive bodies "A" (½-life 25 hr) and "A'" (a few hours) were found both in the air and on the ground. It is suggested that condensation nuclei from nuclear fission explosions have been partially responsible for recent heavy atmospheric precipitation. A. O. STANESBY

551.594.12

667. The rate of atmospheric ionization and the air-earth current at Poona. K. S. AGARWALA. *Indian J. Met. Geophys.*, **2**, 224–6 (*July*, 1951).

These are deduced respectively from measured small ion and condensation nuclei concentrations, using Schweidler's equation, and from negative conductivity and field measurements.

W. C. A. HUTCHINSON

551.594.12

668. The balance of ions in the atmosphere; the production and the disappearance of ions. J. CLAY AND H. VAN MARLE. *Physica*, **17**, 847–57 (*Sept.*, 1951).

It is argued that this is not feasible by establishing the number of ions present and balancing it against the number of ions produced and disappeared, the first mentioned number depending entirely on mobility limit in measurements. A useful method is to establish the number of ions produced above a certain mobility limit by measuring the conductivity in aspirator and in recombination vessel. As the conductivity alters with duration of measurement, a better way is measuring the total number of fast newly produced ions in free atmosphere in a double cage of wire-netting and measuring separately fast ions produced by every known agent. The situation is simplest above the ocean, where cosmic radiation is the only agent. A.

551.594.21

669. Ionic density of the atmospheric air near the ground during thunder-storm conditions. H. NORINDER AND R. SIKSNA. *Ark. Geofys.*, **1**, 453–72 (*Paper* 16, 1951).

Measurements at ground level at Uppsala of the concentration of small ions with an Ebert counter and of large positive ions with an Israël counter during thunderstorms. During the storm a rise in the concentration of small ions occurs and this is greater for negative ions; the rise in ion concentration always occurs in a few minutes during actual precipitation and decays away very rapidly. After the storm is over the density of small ions varies in a very characteristic way. The investigation for large ions was much less complete but on some occasions there was an increase in the measured density of positive ones. The authors conclude that this phenomenon is due to the conveyance of ion producers to the ground from the seat of the thunderstorm. J. M. HOUGH

551.594.5

670. Auroras and luminous night clouds. J. PATON. *Nature* [*Lond.*] **168**, 487–8 (*Sept.* 22, 1951).

A brief, descriptive survey of the phenomena, with passing reference to recent work on low-latitude aurorae with a Scottish "grid" of 4 stations, equipped with specially designed cameras, and linked with Störmer's Scandinavian network. D. R. BARBER

551.594.5 : 535.332

671. O_2^+ and H in the auroral spectrum. C. E. DAHLSTROM AND D. M. HUNTEN. Letter in *Phys. Rev.*, **84**, 378–9 (*Oct.* 15, 1951).

Auroral radiations in the spectral range 3 800–7 000 Å are attributed to H(H_β) and O_2^+ (1st neg. system) excitation. It is suggested that the latter, extending from 5 200 to 6 400 Å, is partially responsible for the colour of type B aurorae, the red colour being developed at the atm. transition level, $0 \rightarrow 0_2$.

D. R. BARBER

551.594.6 : 621.3.018 : 621.396.821

672. The wave form of atmospherics. H. MEINHOLD. *Geofis. Pura Appl.*, **19**, 173–5 (*April–June*, 1951).

The frequency spectrum of the magnetic component of the field change produced by a lightning flash is

derived. On the basis of empirical data on the attenuation of ground waves of different frequencies it is claimed that this varying attenuation is capable of explaining the wave shapes of atmospherics at distances of several hundred miles without taking account of reflections from the ionosphere. R. H. GOLDE

BIOLOGY 57/59

574

673. An experiment in biophysics. J. T. RANDALL. *Proc. Roy. Soc. A*, **208**, 1–24 (*Aug.* 7, 1951).

An account of the biophysics research work done at King's College, London, since 1946. Work is described on subjects including mechanical properties of inorganic gels, development of reflecting microscopes with spherical mirrors, physical properties of catalase, structure of crystals of the nucleoprotein of tobacco mosaic virus, various properties of nucleic acid, the structure of the nuclear membrane, the nuclear structure of root-tip cells and the microstructure of spermatozoa. There are 33 illustrations, including many photomicrographs taken at high magnification (up to 40 000). E. E. CRANE

578.088.5 : 534.321.9

674. Some effects of high-intensity ultrasound on tobacco mosaic virus. N. NEWTON. *Science*, **114**, 185–6 (*Aug.* 17, 1951).

A suspension of the virus was exposed to vibrations of 7 Mc/s for 3·3 min. The infectivity showed a reduction of about 95%. Possible applications of the technique in microbiological work are mentioned.

G. F. HODSMAN

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.2

675. Microrespirometer with automatic electric control of constant oxygen partial pressure. T. C. HELVEY. Letter in *J. Sci. Instrum.*, **28**, 354 (*Oct.*, 1951).

Electrolysis takes place feeding O_2 back into the respiration chamber, and a direct measure of the total O_2 consumption is obtained. J. JACOBS

612.843.2

676. Investigations of several laws of physiological optics, a contribution to the fundamentals of illuminating technique. J. KATZ. *Optik*, **8**, 385–403 (*No.* 9, 1951) *In German.*

Identifying sensation and sensitivity, the writer introduces an arbitrary exponential term involving the time to give a mathematical description of Exner's curves. This and an alternative (parabolic) expression describe them adequately between $t = 0$ and $t = t_{max}$, where t_{max} is the point at which the sensation is a maximum. Broca and Sulzer's data, however, are not accounted for. Blondel and Rey's formula and the Bunsen–Roscoe law are deduced, as are the formulae for the rate of increase of the sensation (Kleitmann and Pieron) and the speed of vision (Cobb). Talbot's law and intermittent stimuli are discussed. Two tables, four figures and a short bibliography are given. R. A. WEALE

612.843.2

677. An extension of Blondel and Rey's law. J. KATZ. *Z. Naturforsch.*, **6a**, 515–16 (*Sept.*, 1951) *In German.*

The luminance B and the minimum time of stimulation t_p required to perceive the contrast ΔB are related by $(\Delta B/B)t_p = \text{const.}$ This formula, due to Zimmermann, is shown to agree with that due to Blondel and Rey. R. A. WEALE

612.843.2

678. The effect of duration of onset and cessation of light flash on the intensity-time relation in the peripheral retina. G. E. LONG. *J. Opt. Soc. Amer.*, **41**, 743–7 (*Nov.*, 1951).

Two experiments are reported. The first studies the intensity-duration function for peripheral threshold stimulation of the human eye, over a range of durations from 0·02 sec to 0·24 sec. The form of the flashes presented involves a rapid onset and cessation (i.e. a nearly rectangular wave). The second determines the total energy required for threshold excitation for flashes of various wave forms (i.e. with different onset and cessation times), the maximum duration always being below the critical duration obtained in the first experiment. The results of the first agree with previous studies in showing that below a certain critical duration the product of light intensity and duration is constant. Above this critical duration the intensity remains constant. The transition from the relationship $It = C$ to $I = \text{Const.}$ is abrupt and occurs at 0·10 sec. The results of the second indicate that changes in the wave form, within the limits of variation introduced, do not affect the total amount of energy required for threshold below the limit of a critical duration. These findings give additional generality to the Bunsen–Roscoe law and to the view that the essential element in producing a constant effect in response to flashes of light is the total energy of the stimulus. A.

612.843.31

679. The influence of luminance level on visual sensitivity to color differences. W. R. J. BROWN. *J. Opt. Soc. Amer.*, **41**, 684–8 (*Oct.*, 1951).

Colour discrimination ellipsoids were obtained for several colours throughout the range of luminances, 10 to 0·03 ft-L. The ellipsoids were determined from three-colour matches by two observers, using a colorimeter with a two-part circular field subtending an angle of two degrees, and a dark surrounding field. It was found that sensitivity to colour differences remains constant for a normal observer until the field luminance drops below about one foot-lambert. Below this level, discrimination decreases rapidly and a normal observer appears tritanomalous. Sensitivity to luminance differences is essentially independent of chromaticity and decreases with luminance in the

same manner as the data obtained from measurement of the Weber fraction with monochromatic or white fields. A.

612.843.31 : 621.397.2

680. Subjective sharpness of additive color pictures. M. W. BALDWIN, JR. *Proc. Instn Radio Engrs*, **39**, 1173–6 (*Oct.*, 1951).

Gives numerical results of an experiment on the subjective sharpness of additive 3-colour pictures. The sharpness factor is isolated by using out-of-focus projection (of slides) instead of actual television transmission. An observer's acuity for defocus is greatest for the green component and least for the blue component, in an additive 3-colour picture. When the same picture is reproduced in monochrome (white, red, green or blue) at the same brightness, his acuity for defocus is equal to that found for the green component. A.

612.843.5 : 621.397.62

681. Flicker in television pictures. J. HAANTJES AND F. W. DE VRIJER. *Philips Tech. Rev.*, **13**, 55–60 (*Sept.*, 1951).

A thorough discussion of flicker on cinema and television screens and of the associated physiological problems is followed by an account of experiments on television screens: the observing distance, the brightness and the composition of the fluorescent material were varied, the frame frequency being kept constant at 50 c/s. The decay time of the fluorescent substance should be as long as possible. With a mixture of a yellow and a blue luminescent silicate a high-light luminance of 200 cd/m^2 is possible without obnoxious flicker being perceived. This is adequate for a background luminance $\geqslant 0$. R. A. WEALE (R)

612.843.612

682. Measurement of visibility. C. L. COTTRELL. *Illum. Engng* [*N.Y.*] **46**, 95–103 (*Feb.*, 1951).

Describes an instrument (monocular or binocular) to measure the brightness difference threshold, with different types of test object, over a wide range of brightness values. The results obtained are compared with those of other workers and the relation to the values of "visibility" given by the Luckiesh–Moss meter is discussed. The possible use of threshold contrasts for prescribing illumination values for specified tasks is suggested. J. W. T. WALSH

612.845

683. Anisopia and perception of space. P. A. CIBIS AND H. HABER. *J. Opt. Soc. Amer.*, **41**, 676–83 (*Oct.*, 1951).

"Anisopia" is here understood to be unequal vision in the two eyes producing unequal imagery. A great variety of physical, physiological and psychological factors are capable of producing anisopia which manifests itself as a characteristic distortion of space because of angular disparity of apparent contours. This anisopic stereo-effect can best be observed by the use of two individual square targets lying in a fronto-parallel plane; the effect consists of an apparent rotation of the individual targets about individual vertical axes. An analysis of anisopia and its significance in vision is attempted, and experiments dealing with anisopia produced by monocular application of neutral density filters, spherical and cylindrical lenses, pupillary diaphragms and bleaching of the retina are described. A.

612.85

684. The exhaustion-vibration analyses and their relation to the theory of hearing. W. MEYER-EPPLER. *Phys. Bl.*, 355–61 (*No.* 8, 1951) *In German.*

Refers to the "raster" method of frequency analysis and applies it to consideration of the psycho-acoustic phenomenon in the theory of hearing. A. B. WOOD

612.85 : 621.396.615.17

685. Objective and subjective resonance effects with short-duration pulse trains. O. SALA. *Frequenz*, **5**, 250–8 (*Sept.*, 1951) *In German.*

A particular form of pulse-train is first described. This consists of a finite, small number of discontinuities separated by a minimum interval of 1 msec, the group being repeated at a frequency of up to 1 c/s. A circuit is shown for producing this train which consists of a condenser and buzzer (producing the main period) controlling the negative bias of a thyratron (producing the group of discontinuities). It is now pointed out that if this waveform is applied to a tuned circuit the output will have several characteristic forms depending on the ratio of the number and duration of the discontinuities to the natural period of the circuit. For example, if the decrement of the circuit is low and the pulse interval is one-half of the natural period, odd numbers of pulses will give rise to a sustained but decaying output while even numbers will excite no such after-response. Using this theory the acoustic phenomenon of subharmonic interference effects with decaying vibrations in resonators is determined as a physiological aural-persistence effect. The possibility of explaining the psycho-physical system as a combination of frequency-analysis and "sound-image-reaction" is discussed. There are numerous diagrams and previous work is adequately reviewed. S. C. DUNN

614.8 : 539.16

686. Symposium on radioactive wastes. *Industr. Engng Chem.*, **43**, 1499–540 (*July*, 1951).

National committee on radiation protection (1500–2); Liquid waste disposal at Oak Ridge national laboratory (1502–5); Concentration of radioactive liquid waste by evaporation (1505–9); Removal of plutonium from laboratory wastes (1509–16); Laboratory studies on removal of plutonium from laundry wastes (1516–20); Activated sludge from foods for treatment of radioactive waste (1520–6); Treatment of radioactive waste by ion exchange (1526–31); Removal of submicron aerosol particles from moving gas stream (1532–8); Treatment of radioactive water by phosphate precipitation (1538–40); Natural radioactivity of water (1541–3). For abstract of last, see Abstr. 9647 (1951).

615.849

687. Low-temperature sterilization of organic tissue by high voltage cathode-ray irradiation. I. A. MEEKER, JR AND R. E. GROSS. *Science*, **114**, 283–5 (*Sept.* 14, 1951).

Human blood vessels, bone and cartilage, for transplantation, have been irradiated with electrons from a 3 MeV electrostatic generator. Irradiation at low temperature (— 80°C) with about 3 million

"rep" units has proved fatal to the bacteria without completely destroying the cells. Of 200 human aortic segments thus irradiated, only 5 produced bacterial growth when cultured. Two human vascular grafts have been successfully made using material sterilized in this way. D. V. MABBS

TECHNICAL MATERIALS 66/67

669 : 541.135

688. Electrolytic deposition of metals on aluminium and aluminium alloys. U. TRÄDGÅRDH. *Tekn. Tidskr.*, **81**, 687–92 (*Sept.* 8, 1951) *In Swedish.*

An outline of the possibilities of improving the quality of Al and its alloys despite the fact that, apart from Mg and the alkali metals, it is the basest metal. However, there are also characteristic difficulties to be overcome in the various "ennobling" or upgrading processes, and these call for preparatory treatments before the upgrading proper is possible. The article is mainly devoted to the description of these preparatory operations, the most important being the contact and cementation methods, or the oxidizing processes, preferably based on anodizing. The most suitable kind of intermediate layer that must be formed before the deposition process can start seems to be known for any desired kind of coating or coating metal. The most generally used preparation process is still Hewitsons etching process with alkaline sodium-zincate solution. B. F. KRAUS

PHOTOGRAPHY 77

771.5

689. Characteristics of a photographic emulsion under intermittent exposure. A. L. KARTUZHANSKIĬ AND P. V. MEĬKLYAR. *Zh. Eksper. Teor. Fiz.*, **21**, 598–609 (*No.* 5, 1951) *In Russian.*

The dependence of the sensibility and the contrast coefficient of a photographic emulsion under intermittent exposure on the total number of light impulses, the duration of the individual impulse and the dark pause and the impulse frequency is investigated. Experimental data were obtained for a series of photographic materials, various densities of blackening and various conditions of development.

B. F. KRAUS

771.53

690. Gold in photographic emulsions. R. KOSLOWSKY. *Z. wiss. Photogr.*, **46**, 65–72 (*No.* 4–6, 1951) *In German.*

A review of the technique of incorporating trace compounds of Au in emulsions to improve sensitivity and granularity. A bibliography is appended.

D. R. BARBER

771.53

691. Two new experimental verifications of the mixed arrangement of lattice defects and their association in silver bromide. O. STASÍW AND J. TELTOW. *Z. Naturforsch.*, **6a**, 363–6 (*July*, 1951) *In German.*

The authors' model of the lattice defects in AgBr is used to explain (1) the dependence of blackening of emulsions exposed at −190°C on the delay between exposure and development, and also on the type of developer; and (2) the production of afterglow in AgBr crystals containing 0·02 mol % Ag_2S, normally luminescent without afterglow at −190°C, by an appropriate temperature treatment. S. T. HENDERSON

771.53

692. On the nature of sensitivity centres in photographic emulsions. A. HAUTOT AND H. SAUVENIER. *Z. Naturforsch.*, **6a**, 370–1 (*July*, 1951) *In French.*

Two sets of experimental results are presented which support the view that sensitivity centres in silver halide emulsions are essentially accidents of crystallization and are created during physical maturation. Chemical maturation mainly serves to make those sensitivity centres already in existence more efficient. A. C. COATES

771.53

693. The structure of the photographic latent image. R. DEBOT. Letter in *J. Opt. Soc. Amer.*, **41**, 732 (*Oct.*, 1951).

A recalculation of previous work, following an experimental confirmation of Kornfeld's results on the absence of an induction period in the solvent action of hypo on Ag halides in emulsions. S. T. HENDERSON

771.53 : 539.27

694. Electron-microscope studies of the physical ripening of dilute AgCl photographic emulsions. H. AMMANN-BRASS. *Z. Naturforsch.*, **6a**, 372–4 (*July*, 1951) *In German.*

The ripening of Ag-halide-gelatine emulsions has been studied with the electron microscope; and it is shown that two types of physical ripening occur: (i) pure Ostwald-ripening, and (ii) particle-size augmentation following coagulation. D. R. BARBER

771.534.53 : 545.82

A gamma-nomograph. *See Abstr.* 624

771.535

695. The Herschel effect. E. H. MYNSTER. *Z. wiss. Photogr.*, **46**, 84–91 (*No.* 4–6, 1951) *In German.*

A filter formula for use with a ciné-projector-lamp source of illumination for producing Herschel effect is given; and the results of testing various brands of Ilford and Agfa blue-sensitive, and panchromatic emulsions for the effect are included. D. R. BARBER

771.535

696. The Herschel and Clayden effects in grain-track emulsions. E. SCHOPPER, S. MAGUN AND W. BRAUN. *Z. Naturforsch.*, **6a**, 338–43 (*July*, 1951) *In German.*

Latent-image Herschel and Clayden effects in

nuclear emulsions exposed to corpuscular radiation are additive, and characteristically different from the effects obtained with "optical" emulsions exposed to either light or particle radiation. In both instances intense post-exposure causes a reversal of the additive effect. D. R. BARBER

771.535

697. *F*-centres in silver bromide and the mechanism of latent image formation. A. HAUTOT. *Bull. Soc. Roy. Sci., Liège*, **20**, 400–12 (*June–July*, 1951) *In French.*

A continuation of a previous article [Abstr. 8416 (1951)]. The nature of sensitivity centres and the role of chemical maturation is discussed further, and a possible mechanism of latent image formation involving *F* centres created by the trapping of photo-electrons at vacant anion sites is put forward. A. C. COATES

771.535

698. Attempts at models for the photographic development process. W. JAENICKE, A. KRÜGER AND K. HAUFFE. *Z. phys. Chem.*, **197**, 161–78 (*June*, 1951) *In German.*

Theories of the latent image have been combined with the notion that electrochemical processes can be superimposed on each other. The two processes concerned are the oxidation of the developer and the reduction of the silver ions. The behaviour of a silver bromide layer in a developer has been investigated experimentally. P. T. LANDSBERG

778.3

699. On underwater photography. A. IVANOFF. Letter in *J. Opt. Soc. Amer.*, **41**, 645–6 (*Sept.*, 1951).

The use of a plane window under water restricts the field of the lens. A simple two-lens optical system removes this defect and yields a virtual image, free from astigmatism and chromatic aberration, apparently located at the object position in air. R. W. FISH

778.33

700. Iridium 192 for gamma ray radiography. A. MORRISON. *Non-Destr. Test.*, **10**, 26–8 (*No.* 1, 1951).

The technical and commercial aspects of the use of radioactive iridium for radiography are discussed. It is found, at present, that Co^{60} is as good as and, because of its longer half-life and lower price, a more economical source than Ir^{192}. W. SUMMER

778.33

701. Intensification of underexposed industrial radiographs. G. M. CORNEY AND H. R. SPLETTSTOSSER. *Non-Destr. Test.*, **10**, 29–32 (*No.* 1, 1951).

Chemical intensification of the processed film with Kodak intensifier In-6 may result in a speed gain of 5–7. The method and technique are described in full detail. Intensification increases the fog level as well as contrast. Kodak type K industrial X-ray films have the best (intensified-to-original) density ratio. W. SUMMER

778.33

702. Photographic fundamentals of autoradiography. R. H. HERZ. *Nucleonics*, **9**, 24–39 (*Sept.*, 1951).

The autoradiography of macrosections is reviewed very briefly. Greater attention is devoted to the recording of radioactive tracers (mainly β-emitters) in microscopic sections. The suitability of various types of photographic emulsion for this purpose is discussed. Nuclear plates of medium sensitivity find the widest use at present. Techniques for mounting the emulsion in intimate contact with the specimen are described. Factors affecting resolution, the sensitivity of the emulsions and the quantitative assessment of the activity of the tracer in any given region of the specimen are discussed. Attention is drawn to possible advantages of observing particle tracks rather than the density of developed grains. L. R. SHEPHERD

778.33 : 578

703. X-ray micro-radiography of biological specimens. W. EHRENBERG AND W. E. SPEAR. Letter in *Nature* [*Lond.*] **168**, 513–14 (*Sept.* 22, 1951).

Describes use of a highly loaded micro-focus X-ray tube and a technique which relies entirely on optical magnification of shadow-graph. Specimen is mounted on a collodion film 0·2 mm from a photographic plate of high resolution. T. A. CHALMERS

778.34

704. Study of heavy nuclei by the photographic emulsion method. Thinning down of tracks towards the end of their range. T.-F. HOANG. *J. Phys. Radium*, **12**, 739–43 (*July–Aug.–Sept.*, 1951) *In French.*

The relationship between the charge of a heavy particle, the density of delta-rays along its track and the range at which this density is measured, is derived. An approximation is made to simplify the formulae and experimental values of the three constants involved are given. The length of track over which the thinning-down effect takes place has been observed to be an approximately linear function of the charge of the particle producing the track. A. C. COATES

778.34

705. Range measurements in nuclear emulsions having a high background. V. E. DYKE. Letter in *J. Sci. Instrum.*, **28**, 320–1 (*Oct.*, 1951).

The effect of gamma-ray irradiations of up to 10 roentgens is shown to be of small importance for range measurements of 4·5 MeV protons in Ilford E.1 nuclear track plates, despite the observed increase in the spread of the measurements with increasing irradiation. Ilford G.5 and Kodak N.T.4 plates become unusable for range determinations after receiving gamma irradiations greater than 0·1 roentgen. A. C. COATES

778.35

706. Use of the Herschel effect in improving aerial photographs. M. JOHNSON. *J. Opt. Soc. Amer.*, **41**, 748–51 (*Nov.*, 1951).

A resolving power criterion is used to evaluate a method which utilizes the Herschel effect to improve the resolution of aerial photographs. The maximum resolving power is increased and the useful exposure range is considerably widened in a Herschel print. To minimize exposure times, the sensitivity of Koda-bromide paper to the Herschel effect is increased by a desensitizer. Although equivalent resolution may be obtained by the use of unsharp masks, the economy

of time and material in the Herschel method makes it superior for application to mass printing operations. A.

778.35

707. New criteria for contact printing in aerial photography. L. E. HOWLETT AND D. L. MATTHEWS. *J. Opt. Soc. Amer.*, **41**, 752–9 (*Nov.*, 1951).

Applies resolving power methods to the selection and exposure of contact photographic papers for aerial photography. Negatives on Aero Super-XX and Aero Panatomic-X have been used for the investigation. Most of the work was done with a chloride emulsion but some experiments with a bromide emulsion led to similar conclusions. It was found that with Aero Super-XX the most generally useful single print is made on a low contrast grade of paper, except for restricted brightness ranges of low contrasts. With Aero Panatomic-X, a single high contrast grade should be used. The higher resolution of the finer grained film is partially lost in the printing. Glossy paper preserves most of the available information on the film, though much inferior to transparencies. Other paper surfaces lead to more or less serious losses. Effects of inaccurate paper exposure are shown for different contrast grades. Exposure tolerance and resolving power over the useful range of the film indicate the lower contrast grades to be the most useful for the great majority of air negatives on Aero Super-XX Great over-exposure but only slight under-exposure of film may be compensated for in printing. Maximum and minimum usable paper densities are given. A.

778.37

708. Self adjusting timer for bullet photography. J. BURLOCK. *Rev. Sci. Instrum.*, **22**, 743–5 (*Oct.*, 1951).

An instrument is described which measures a time interval and then immediately generates an interval of time equal to the measured interval, for automatically timing a light source flash for photographing missiles whose velocity cannot be predicted. A.

778.37 : 537.54

709. High-power photo-flash tubes. M. LAPORTE. *Nature* [*Lond.*] **168**, 552 (*Sept.* 29, 1951).

Tubes have been made with an output of the order of 1 kW. Design details are given, including Kovar to Moly glass seals and the use of a narrow quartz section to locate and concentrate the light output. S. T. HENDERSON

778.6

710. Spectral sensitometry of multi-layer colour-photography materials. YU. N. GOROKHOVSKIĬ AND O. M. PONOMARENKO. *Dokl. Akad. Nauk, SSSR*, **79**, 591–3 (*No.* 4, 1951) *In Russian.*

The method of spectral-energy sensitometry [Gorokhovskiĭ, *Trudy Gosudarstvennogo Opticheskogo Instituta*, **14**, 321 (1941)] has been used for the investigation on 2 negative and 2 positive colour-photography materials in the ranges of 425–750 and 250–450 mμ. After the usual colour development, the densities for 3 selected wavelengths have been determined in the spectro-sensitographs obtained by using an electrical micro-spectrophotometer [Gorokhovskiĭ, Balabukha and Levenberg, Abstr. 990 (1951)]. The relative surface concentrations of dyes have been calculated, and the curves of the spectral light sensitivity and the monochromatic coefficient of contrast determined. It has been found that the non-sensitized upper layers of the negative and positive materials have the same curves of spectral light sensitivity. The medium (green-sensitive) layers differ slightly in their properties, while the bottom (red-sensitive) layers of positive materials have a much wider zone of sensitization than in the case of the negative materials, and the sensitivity of the former extends to the infrared. In the case of positive materials, the coefficient of contrast depends much more upon the wavelength of the emission than in negative materials. F. LACHMAN

778.6 : 535.64

711. Some colour spaces used in the theory of colour photography. E. HELLMIG. *Z. Naturforsch.*, **6a**, 353–60 (*July*, 1951) *In German.*

An examination of different colour spaces proposed for use in photographic colour theory, particularly those of S. Rösch [*Phys. Z.*, **29**, 83–91 (*Feb.* 1, 1928)] and R. Luther [*Z. Phys.*, **8**, 540–58 (1927)]. In the former the lines representing mixtures of two colours are, in general, curved, whereas they are straight in the Luther colour space and in the C.I.E. system. Transformations from one system to another are discussed. J. W. T. WALSH